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ABSTRACT

To assist teachers in agricultural mechanics in providing comprehensive instruction to their students, this curriculum guide treats both the mechanical skills and knowlege necessary for this specialized area. Six sections are included, as follow: orientation and safety; agricultural mechanics skills; agricultural power and machinery; agricultural electric power and processing; agricultural building; and the farm level and legal land description. Each section is composed of one or more instructional units which are organized into eight parts: (1) student behavioral objectives, which state the goals of the course; (2) suggested activities outlining steps for both students and instructors to accomplish specific objectives; (3) information sheets, which provide the content necessary to meet the knowledge objectives of the unit; (4) transparency masters to reinforce the learning process; (5) job sheets, which outline the skills being taught; (6) assignment sheets for homework or classroom use (answer sheets are also included); (7) paper-pencil and performance tests constructed to measure student achievement of each objective; and (8) test answers. (ELG)

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VOCATIONAL AGRICULTURE EDUCATION

AGRICULTURAL MECHANICS

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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For the Division of Vocational Agriculture
Byrle Killian, State Supervisor
OKLAHOMA STATE BOARD OF VOCATIONAL AND TECHNICAL EDUCATION
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1977

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FOREWORD

This publication is designed to provide instruction in a specialized course in agricultural mechanics. Today, teachers of agricultural mechanics are faced with the increasing problem of what to teach in a specialized course of mechanics. They are further hampered by double enrollment of students in production agriculture and agricultural mechanics. The agricultural mechanics student of today needs to have a well-rounded program of mechanical skills. The purpose of this guide is to assist teachers in improving instruction in a specialized course in agricultural mechanics in Oklahoma.

Appreciation is expressed to the many individuals who helped in the development of this publication. The teaching of vocational agricultural mechanics should become more effective with its use.

Francis T. Tuttle, State Director
State Department of Vocational and
Technical Education

Byrle Killian, State Supervisor
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PREFACE

Up until now, most vocational agriculture graduates were being prepared to return to the farm. Now, an increasing number are entering occupations other than farming with a large number of them finding employment in the agricultural mechanics area. With this increase of students enrolling in a mechanics class and since these students require a highly skilled program, an up-to-date curriculum was necessary.

We have made every effort to make this publication basic, readable, and, by all means, usable. We have attempted to build on the mechanical skills from *Vocational Agriculture: Basic Core Curriculum. Agricultural Mechanics* has been broken out into the six areas of instruction required by the State Board of Vocational-Technical Education for a specialized class offering in agricultural mechanics. Three vital parts of instruction have been omitted from this publication intentionally: motivation, personalization, and localization. These areas are left to the individual instructors, and the instructors should capitalize on them. Only then will the publication become a vital part of the teaching-learning process.

Instructors should carefully look at this publication and identify and secure the necessary tools and equipment necessary for proper implementation. It is also recommended that instructors secure service manuals from the different dealers and manufacturers of tractors and equipment.

With the use of this publication it is hoped that each teacher will realize the effectiveness of this approach to teaching a specialized course in agricultural mechanics. Today, students can be enrolled in both production agriculture and a special course in agricultural mechanics without having to repeat subject matter.

This approach to teaching focuses all resource material toward a measurable outcome. The student should be able to perform at a higher level because both the student and the instructor know exactly where the other is going.

The Curriculum and Instructional Materials Center staff wishes you every success with implementation of this in-depth course offering in agricultural mechanics. If we may be of assistance, please let us know. We will be most happy to help.

Bob Patton, Coordinator
Curriculum and Instructional
Materials Center
State Department of Vocational-
Technical Education

ACKNOWLEDGMENTS

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Eddie Smith
Dr. Clifton R. (Pete) Braker
Bob Patton

USE OF THIS PUBLICATION

Instructional Units

Agricultural Mechanics includes six areas. Each area consists of one or more units of instruction. Each instructional unit includes behavioral objectives, suggested activities for teacher, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help him/her determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials, such as pamphlets and filmstrips, that must be ordered
D. Resource people who must be contacted

Objectives

Each unit of instruction is based on behavioral objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Behavioral objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When a teacher adds objectives, he/she should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of the instructor will vary according to the particular unit. However, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheet

The information sheet provides content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that the information sheet serves as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before the information is discussed in class. Students may take additional notes on the information sheet.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he/she has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances he/she might reasonably expect from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

[redacted]

ORIENTATION AND GENERAL SAFETY
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to discuss agricultural mechanics. The student should also be able to match occupations in agricultural mechanics to their correct descriptions and list rules for keeping a clean and orderly shop. This knowledge will be evidenced by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Discuss agricultural mechanics.
2. List reasons agricultural mechanics instruction is important to the agricultural industry.
3. Select from a list purposes for training in agricultural mechanics skills.
4. List rules for keeping a clean and orderly shop.
5. Match occupations in agricultural mechanics to their correct descriptions.
6. List the purposes of the safety color code as used in agricultural mechanics programs.
7. Match the colors used in the safety color code to the proper descriptions.
8. Discuss in a short paragraph *Oklahoma State Law* 824, Section 1407, regarding eye protection in the shop.
9. List steps to be taken involving accidents and first aid.
10. List the components of the fire triangle.
11. Match the classes of fires to statements defining each class.
12. Match types of fire extinguishers to their uses.
13. Complete general shop test.
14. Complete safety practice form.

ORIENTATION AND GENERAL SAFETY
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Develop a clean-up procedure for your shop.

   E. Discuss unit and specific objectives.

   F. Discuss information and assignment sheets.

   G. Give test.

II. Unit references:

   A. *Instructional Materials for Vocational Agriculture I.* College Station, Texas: Teaching Materials Center, Agriculture Education Department, Texas A & M University.

   B. Sneep, Neil O. *Vocational Agriculture Training Programs: Safe Tractor Operation and Safe Farm Machinery Operation.* East Lansing, Michigan: Rural Manpower Center, Michigan State University, 1969.

   C. Schmidt, A. W.; Witt, D. J.; Mills, Loren; and Pearson, Charles. *Safe Practices in the Vocational Agriculture Shop*. Urbana, Illinois: Teachers of Vocational Agriculture, State of Illinois.

   D. Cook, George. "Test Materials Handout and Job Sheets." Prepared by Agricultural Engineering 4220 class. Mimeographed. Stillwater: Oklahoma State University, 1963.

   E. Williams, William A. *Accident Prevention Manual for Shop Teachers.* Chicago: American Technical Society, 1963.

   F. *Best's Safety Directory.* Morriston, New Jersey: A. M. Best Co., 1968.

   G. Ross, Henry, and Craig, R. N. *Modern Farm Shop.* Austin, Texas: Steck-Vaughn Co., 1954.

H. *A Guide for Course Planning in Introduction to Agriculture.* Raleigh, North Carolina: Division of Vocational Education, Agricultural Education Section, Department of Public Instruction.

I. Hoover, Norman K. *Handbook of Agricultural Occupations.* Danville, Illinois: Interstate Printers and Publishers, 1963.

J. *Oklahoma State Law* (1970). No. 824, Section 1407.

K. Phipps, Lloyd J. *Mechanics in Agriculture.* Danville, Illinois: Interstate Printers and Publishers, Inc., 1970.

ORIENTATION AND GENERAL SAFETY
UNIT I

INFORMATION SHEET

I. Agricultural mechanics--All the unspecialized mechanical activities performed on the farm and in the home

  A. Agricultural mechanics skills

  (NOTE: This includes areas such as selection, sharpening, care, and correct use of shop tools and equipment; woodwork and simple carpentry; sheet metal work; elementary forge work; electric arc and oxyacetylene welding; pipe fitting; simple plumbing repairs; and rope work.)

  B. Agricultural power and machinery

  (NOTE: This includes selection, management, adjustment, operation, maintenance, and repair [excluding major repair requiring specialized equipment and services]engines, trucks, tractors, trailers, and machinery used in farming and agriculturally-oriented business and services.)

  C. Agricultural electrical power and processing

  (NOTE: This includes utilization of electricity in the home and in productive enterprises and selection, installation, operation, and maintenance of electrical equipment.)

  D. Agricultural structures

  (NOTE: This includes elementary scale drawing and plan reading; farmstead layout; functional requirements of houses, shelters, and storages; water systems; and septic tanks and sewage disposals.)

  E. Soil and water management

  (NOTE: This includes elementary leveling; land measurement and mapping; drainage; irrigation; terracing; and contouring.)

II. Importance of agricultural mechanics instruction to the agricultural industry

  A. Most of the work involves some type of mechanical activity

  B. Approximately 85 percent of machinery in operation is out of adjustment

  C. Student must be able to service and maintain all equipment used

INFORMATION SHEET

III. Purposes for training in agricultural mechanics skills

   A. Aids students in discovering mechanical aptitudes

   B. Trains students in basic skills needed on the farm and for related agricultural industries

   C. Prepares students for future training in mechanics

   D. Prepares students for entry into job opportunities after high school

IV. Rules for keeping a clean and orderly shop

   A. Store equipment being repaired or constructed in an orderly fashion at the end of the work period

   B. Clean and store tools, helmets, and goggles in their proper places at the end of the work period

   C. Report broken tools to the teacher

   D. Place oily rags in covered metal container

   E. Turn off all arc welders when job is done

   F. Shut off oxyacetylene welding outfits at cylinders, drain hoses, close oxygen and acetylene blow pipe valves, clean welding tables, and restore rods to the holders at the close of the work period

   G. Be responsible for the area or station assigned to you

   H. Brush all benches, tables, and the floor at end of work period

   I. Keep tools in their proper places

   J. Do not scuffle or join in horseplay in the shop

   K. Do not run in the shop

   L. Do not work with tools in which you have not received instruction

   M. Make sure that all electrical equipment is turned off at end of day

   N. Use tools for their specific purposes

   O. Supply all visitors with face shields upon entering the shop

   P. Store personal property, including project property, in designated locations

INFORMATION SHEET

Q. Do not waste time

(NOTE: Conduct in the shop should be the same as during regular class time.)

R. Check all clothes before returning them to lockers after class time

V. Agricultural mechanics occupations

A. Welder--Repairs and builds metal equipment

B. Farm machinery operator--Operates farm equipment as a farm employee

C. Mechanic--Repairs and overhauls engines, hydraulic systems, and electrical systems

D. Mechanic's helper--Assists mechanic and is in training to become a mechanic

E. Farm machinery parts manager--Handles parts and repairs in a machinery dealership

F. Farm machinery salesperson--Works in a dealership selling farm machinery and equipment

G. Farm machinery field person--Assists farmers with problems in operating their equipment

H. Set-up and delivery person--Works in a dealership in setting up and assembling equipment and delivers from the dealership to the farm

I. Soil and water conservationist--Assists farmers and ranchers in preparing a good conservation plan for use and treatment of their land

VI. Purposes of the safety color code

A. Reduces glare by diffusing sufficient light for better vision throughout the shop

B. Reduces eyestrain, tension, and fatigue by "setting off" material from machines and work areas

C. Promotes safety by pointing out critical parts and areas

D. Promotes better housekeeping by providing a more pleasing environment

INFORMATION SHEET

VII. Colors used in the safety color code

A. Green--Applied to noncritical parts of equipment and machine surfaces, nameplates, and bearing surfaces; used to designate the location of safety and first aid equipment

B. Yellow--Applied to operating levers, wheels, handles, and hazardous areas which may cause stumbling, falling, or tripping; used to designate caution

C. Orange--Applied to electrical switches, interior surfaces of doors, fuse and electrical power boxes, movable guards and parts, inside of nonmovable guards, traffic lanes, and overhead hazards; used to designate dangerous parts of equipment which may cut, crush, shock, or otherwise injure

D. Red--Used to identify the location of fire-fighting equipment

(NOTE: This is the physical color associated with fire. Emergency fire exits shall be designated in red. Buttons or levers for electrical switches used for stopping machinery should be designated in red. Gasoline cans should be painted red with additional identification in the form of a yellow band around the can.)

E. Blue--Used as the basic color for designating caution against starting equipment while it is being worked on or against the use of defective equipment

(NOTE: A blue tag should be attached to defective equipment. The tag should be labeled Out of Order.)

F. Ivory--Applied to table edges, vise jaws, and edges of tool rests to reflect light and "show the way"

G. Aluminum--Applied to tops of tables and work areas to provide contrast with work

(NOTE: This can also be designated by unpainted steel.)

VIII. Summary of *Oklahoma State Law* 824, Section 1407, regarding eye protection in shops

A. REQUIRES THAT EYE PROTECTIVE DEVICES BE WORN IN CERTAIN COURSES OF INSTRUCTION

B. Protects student and teacher participating in or observing instruction

INFORMATION SHEET

C. Cautions against harmful conditions

1. Hot molten metals or other molten materials
2. Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials
3. Heat treatment, tempering, or kiln firing of any metal or other materials
4. Gas or electric arc welding or other forms of welding processes
5. Repair or servicing of any vehicle where there is danger of injury to the eyes
6. Caustic or explosive materials

IX. Steps to be taken involving accidents and first aid

A. Accidents--Report all accidents to the teacher immediately

(NOTE: If a serious injury is apparent, the hospital or school nurse should be contacted immediately. Do not attempt to move victim until help arrives.)

B. First aid

1. Stop the bleeding
2. Clear the airway
3. Treat for shock

X. Components of the fire triangle (Transparency 1)

A. Fuel

B. Oxygen

C. Heat

(NOTE: To produce fire these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started, or with the removal of any one of them, the fire will be extinguished.)

INFORMATION SHEET

XI. Classes of fires

A. Class A--Fires that occur in ordinary combustible materials

Examples: Wood, rags, and rubbish

B. Class B--Fires that occur with flammable liquids

Examples: Gasoline, oil, grease, paints, and thinners

C. Class C--Fires that occur in or near electrical equipment

Examples: Motors, switchboards, and electrical wiring

D. Class D--Fires that occur with combustible metals

Example: Magnesium

XII. Types of fire extinguishers (Transparency 2)

A. Pressurized water--Used on Class A fires

(NOTE: This type of fire extinguisher is usually operated by squeezing a handle or trigger.)

B. Soda acid--Used in Class A fires

(NOTE: This type is operated by turning the extinguisher upside down.)

C. Carbon dioxide (CO_2)--Used on Class B and C fires

(NOTE: This type is usually operated by squeezing a handle or a trigger.)

D. Dry chemical--Used on Class B, C, and D fires

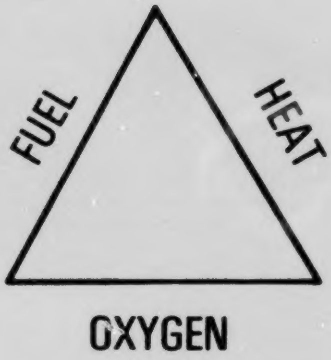
(NOTE: This type is usually operated by squeezing a handle, trigger, or lever.)

E. Foam--Used on Class A and B fires

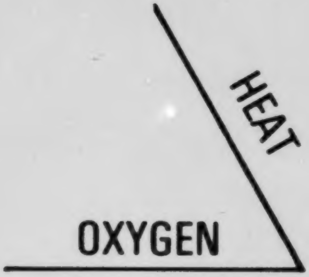
(NOTE: This type is operated by turning the extinguisher upside down.)

The Fire Triangle

To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
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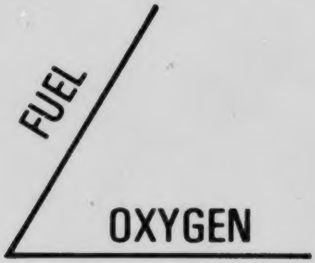
FUEL
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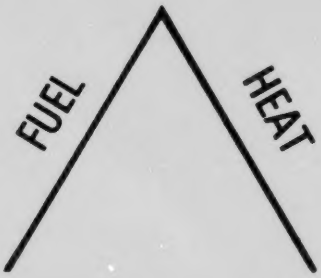
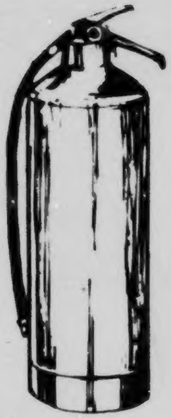
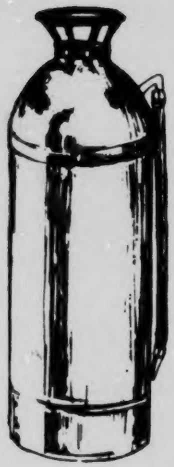


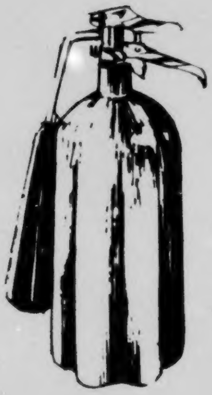
Types of Fire Extinguishers



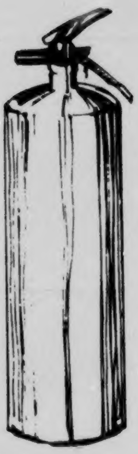
Pressurized Water



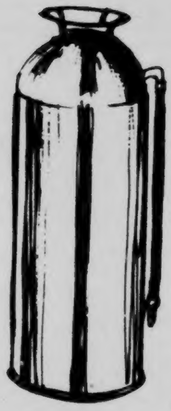
Soda-Acid



Carbon Dioxide



Dry Chemical



Foam

ORIENTATION AND GENERAL SAFETY
UNIT I

ASSIGNMENT SHEET #1--GENERAL SHOP SAFETY TEST

Complete the shop safety test below by circling "T" if true and "F" if false.

T F 1. You should always learn the right way to do a job.

T F 2. Always work at a fast speed.

T F 3. Report all injuries to instructor.

T F 4. Observe all warning signs and tags.

T F 5. Unless you have been taught to operate a machine, stay away from it.

T F 6. Never attempt to make adjustment or clear a jam while a machine is running.

T F 7. Guards may be left off some machines.

T F 8. It is permissible to leave a machine running while not in use.

T F 9. Remove chuck wrenches from chucks immediately after wrench is used.

T F 10. Use only tools and equipment in good condition.

T F 11. Equip files with handles before using them.

T F 12. Always use the proper tool for the job.

T F 13. When lifting an object, be sure you have good footing, then jerk the object.

T F 14. Wear goggles when there is a chance of getting foreign material in your eye.

T F 15. When working on or near machinery, don't wear worn or ragged clothing.

T F 16. Before using a hammer, check the trademark.

T F 17. When chiseling metal, wear goggles and caution nearby students against sparks.

ASSIGNMENT SHEET #1

T F 18. To avoid flying metal chips, never use a chisel with a mushroom head.

T F 19. When using a cold chisel on an empty barrel, the barrel should be filled with air.

T F 20. Always put out the torch when it becomes necessary to readjust the work.

T F 21. Always handle hot metal with gloves.

T F 22. Open cylinder valves quickly.

T F 23. Never use oil on oxyacetylene regulators.

T F 24. Never use oxygen as a substitute for compressed air.

T F 25. Release adjusting screw on oxygen regulator before opening cylinder valve.

T F 26. To light the oxyacetylene torch, use a match.

T F 27. It is permissible to adjust the arc welding machine while it is running.

T F 28. When striking an arc always say "cover."

T F 29. Do not use worn or frayed cables when running a welding machine.

T F 30. First aid stations are marked with a red cross.

T F 31. "Horseplay" should never occur in the shop.

T F 32. Always have good ventilation when working.

T F 33. Always place jack stand under heavy objects when working.

T F 34. When using the oxyacetylene torch never set the acetylene pressure above 15 psi.

____
Student's Signature

____
Advisor's Signature

____
Score

ORIENTATION AND GENERAL SAFETY
UNIT I

ASSIGNMENT SHEET #2--SAFETY PRACTICE FORM

Complete this safety practice form and return to instructor for filing

______________________________ HIGH SCHOOL

______________________________, who is enrolled in a vocational ____________________ course, will, as a part of the shop experience, operate machines, providing that the parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it.

The student must assume responsibility for the following safe practices, and we, therefore, ask that the student subscribe to the following safety pledge.

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the teacher.
3. I will not ask permission to use a particular machine unless I have been instructed in it's use and have made 100% on the safety test given on that machine.
4. I will report any accident or injury to the teacher immediately.

Date ____________________ Student's Signature ______________________________

I hereby give my consent to allow my son or daughter to operate all machines and equipment necessary to carry out the requirements of the course in which he/she is enrolled.

Date ____________________ Parent's Signature ______________________________

Parents are cordially invited to visit the shops to inspect the machines and to see them in operation at any time.

(Note: Parental consent is necessary only if the student is a minor.)

ORIENTATION AND GENERAL SAFETY
UNIT I

ANSWERS TO ASSIGNMENT SHEET #1

1. T
2. F
3. T
4. T
5. T
6. T
7. F
8. F
9. T
10. T
11. T
12. T
13. F
14. T
15. T
16. F
17. F
18. T
19. F
20. T
21. F
22. F
23. T
24. T
25. T
26. F
27. F
28. T
29. T
30. F
31. T
32. T
33. T
34. T

ORIENTATION AND GENERAL SAFETY
UNIT I

TEST

NAME ______________________________ SCORE ________________

1. Discuss agricultural mechanics.

____

____

____

____

____

____

2. List two reasons agricultural mechanics instruction is important to the agricultural industry.

a. ____

b. ____

3. Select from the list below purposes for training in agricultural mechanics skills. Place an "X" in front of the correct statements.

_____a. Aids students in continuing their education

_____b. Aids students in discovering mechanical aptitudes

_____c. Prepares students for entry into job opportunities after high school

_____d. Trains students in basic skills needed on the farm and for related agricultural industries

_____e. Prepares students for entry into college

4. List ten rules for keeping a clean and orderly shop.

a. ____

b. ____

c. ____

d. ____

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

5. Match occupations in agricultural mechanics to their correct descriptions. Place the appropriate numbers in the blanks provided.

______a. Operates farm equipment as a farm employee

______b. Assists mechanic and is in training to become a mechanic

______c. Works in dealership selling farm machinery and equipment

______d. Repairs and builds metal equipment

______e. Repairs and overhauls engines, hydraulic systems, and electrical systems

______f. Handles parts and repairs in a machinery dealership

______g. Assists farmers with problems in operating their equipment

______h. Assists farmers and ranchers in preparing a good conservation plan for use and treatment of their land

______i. Works in dealership in setting up or assembling equipment and delivers from the dealership to the farm

1. Welder
2. Farm machinery operator
3. Mechanic
4. Mechanic's helper
5. Farm machinery parts manager
6. Farm machinery salesperson
7. Farm machinery field person
8. Set-up and delivery person
9. Soil and water conservationist

6. List the purposes of the safety color code as used in agricultural mechanics programs.

a. ______________________________

____

b. ____

____

c. ____

____

d. ____

____

7. Match the colors used in the safety color code to the proper descriptions.

_____a. Applied to electrical switches, interior surfaces of doors, fuse and electrical power boxes, movable guards and parts, inside of nonmovable guards, traffic lanes, and overhead hazards; used to designate dangerous parts of equipment which may cut, crush, shock, or otherwise injure

_____b. Applied to operating levers, wheels, handles, and hazardous areas which may cause stumbling, falling, or tripping; used to designate caution

_____c. Applied to noncritical parts of equipment and machine surfaces, nameplates, and bearing surfaces; used to designate the location of safety and first aid equipment

_____d. Applied to tops of tables and work areas to provide contrast with work

_____e. Used to identify the location of fire fighting equipment

_____f. Applied to table edges, vise jaws, and edges of tool rests to reflect light and "show the way"

_____g. Used as the basic color for designating caution against starting equipment while it is being worked on or against the use of defective equipment

1. Green
2. Aluminum
3. Yellow
4. Red
5. Blue
6. Orange
7. Ivory

8. Discuss in a short paragraph *Oklahoma State Law* 824, Section 1407, regarding eye protection in the shop.

____

____

____

____

____

____

____

____

____

____

____

____

9. List steps to be taken involving accidents and first aid.

   a. Accidents

      ____

   b. First aid

      1) ____________________

      2) ____________________

      3) ____________________

10. List the components of the fire triangle.

   a. ____________________

   b. ____________________

   c. ____________________

11. . Match tne classes of fire to the correct statements defining each class.

_____a. Fires that occur with flammable liquids

_____b. Fires that occur in ordinary combustible materials

_____c. Fires that occur in or near electrical equipment

_____d. Fires that occur with combustible metals

1. Class A
2. Class B
3. Class C
4. Class D

12. Match types of fire extinguishers to their uses. A blank may have more than one correct answer.

_____a. Used on Class A fires

_____b. Used on Class B, C, and D fires

_____c. Used on Class A and B fires

_____d. Used on Class B and C fires

1. Pressurized water
2. Carbon dioxide (CO_2)
3. Dry chemical
4. Soda acid
5. Foam

13. Complete general shop safety test.

14. Complete safety practice form.

(NOTE: If activities 13-14 have not been accomplished prior to the test, ask the instructor when they should be completed.)

ORIENTATION AND GENERAL SAFETY
UNIT I

ANSWERS TO TEST

1. Discuss agricultural mechanics.

   All the unspecialized mechanical activities performed on the farm and in the home

   a. Agricultural mechanics skills

   b. Agricultural power and machinery

   c. Agricultural electrical power and processing

   d. Agricultural structures

   e. Soil and water management

2. List two reasons agricultural mechanics instruction is important to the agricultural industry.

   (NOTE: Any two of the following are acceptable.)

   a. Most of the work involves some type of mechanical activity

   b. Approximately 85 percent of machinery in operation is out of adjustment

   c. Student must be able to service and maintain all equipment used

3. Select from the list below purposes for training in agricultural mechanics skills. Place an "X" in front of the correct statements.

   _____ a. Aids students in continuing their education

   __X__ b. Aids students in discovering mechanical aptitudes

   __X__ c. Prepares students for entry into job opportunities after high school

   __X__ d. Trains students in basic skills needed on the farm and for related agricultural industries

   _____ e. Prepares students for entry into college

4. List ten rules for keeping a clean and orderly shop.

   (NOTE: Any ten of the following are acceptable.)

   a. Store equipment being repaired or constructed in an orderly fashion at the end of the work period

   b. Clean and store tools, helmets, and goggles in their proper places at the end of the work period

c. Report broken tools to the teacher

d. Place oily rags in covered metal container

e. Turn off all arc welders when job is done

f. Shut off oxyacetylene welding outfits at cylinders, drain hoses, close oxygen and acetylene blow pipe valves, clean welding tables, and restore rods to the holders at the close of the work period

g. Be responsible for the area or station assigned to you

h. Brush all benches, tables, and the floor at end of work period

i. Keep tools in their proper places

j. Do not scuffle or join in horseplay in the shop

k. Do not run in the shop

l. Do not work with tools in which you have not received instruction

m. Make sure that all electrical equipment is turned off at end of day

n. Use tools for their specific purposes

o. Supply all visitors with face shields upon entering the shop

p. Store personal property, including project property, in designated locations

q. Do not waste time

r. Check all clothes before returning them to lockers after class time

5. Match occupations in agricultural mechanics to their correct descriptions. Place the appropriate numbers in the blanks provided.

__2__ a. Operates farm equipment as a farm employee

__4__ b. Assists mechanic and is in training to become a mechanic

__6__ c. Works in dealership selling farm machinery and equipment

__1__ d. Repairs and builds metal equipment

__3__ e. Repairs and overhauls engines, hydraulic systems, and electrical systems

__5__ f. Handles parts and repairs in a machinery dealership

Welder

2. Farm machinery operator

3. Mechanic

4. Mechanic's helper

5. Farm machinery parts manager

6. Farm machinery salesperson

7 g. Assists farmers with problems in operating their equipment

9 h. Assists farmers and ranchers in preparing a good conservation plan for use and treatment of their land

8 i. Works in dealership in setting up or assembling equipment and delivers from the dealership to the farm

7. Farm machinery field person
8. Set-up and delivery person
9. Soil and water conservationist

6. List the purposes of the safety color code as used in agricultural mechanics programs.

   a. Reduces glare by diffusing sufficient light for better vision throughout the shop

   b. Reduces eyestrain, tension, and fatigue by "setting off" material from machines and work areas

   c. Promotes safety by pointing out critical parts and areas

   d. Promotes better housekeeping by providing a more pleasing environment

7. Match the colors used in the safety color code to the proper descriptions.

6 a. Applied to electrical switches, interior surfaces of doors, fuse and electrical power boxes, movable guards and parts, inside of nonmovable guards, traffic lanes, and overhead hazards; used to designate dangerous parts of equipment which may cut, crush, shock, or otherwise injure

3 b. Applied to operating levers, wheels, handles, and hazardous areas which may cause stumbling, falling, or tripping; used to designate caution

1 c. Applied to noncritical parts of equipment and machine surfaces, nameplates, and bearing surfaces; used to designate the location of safety and first aid equipment

2 d. Applied to tops of tables and work areas to provide contrast with work

1. Green
2. Aluminum
3. Yellow
4. Red
5. Blue
6. Orange
7. Ivory

4 e. Used to identify the location of fire fighting equipment

7 f. Applied to table edges, vise jaws, and edges of tool rests to reflect light and "show the way"

5 g. Used as the basic color for designating caution against starting equipment while it is being worked on or against the use of defective equipment

8. Discuss in a short paragraph *Oklahoma State Law* 824, Section 1407, regarding eye protection in the shop.

   a. REQUIRES THAT EYE PROTECTIVE DEVICES BE WORN IN CERTAIN COURSES OF INSTRUCTION

   b. Protects student and teacher participating in or observing instruction

   c. Cautions against harmful conditions

      1) Hot molten metals or other molten materials

      2) Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials

      3) Heat treatment, tempering, or kiln firing of any metal or other materials

      4) Gas or electric arc welding or other forms of welding processes

      5) Repair or servicing of any vehicle where there is danger of injury to the eyes

      6) Caustic or explosive materials

9. List steps to be taken involving accidents and first aid.

   a. Accidents--Report all accidents to the teacher immediately

   b. First aid

      1) Stop the bleeding

      2) Clear the airway

      3) Treat for shock

10. List the components of the fire triangle.

    a. Fuel

    b. Oxygen

    c. Heat

11. Match the classes of fire to the correct statements defining each class.

    2 a. Fires that occur with flammable liquids

    1 b. Fires that occur in ordinary combustible materials

    3 c. Fires that occur in or near electrical equipment

    4 d. Fires that occur with combustible metals

    1. Class A
    2. Class B
    3. Class C
    4. Class D

12. Match types of fire extinguishers to their uses. A blank may have more than one correct answer.

    1,4,5 a. Used on Class A fires

    3 b. Used on Class B, C, and D fires

    5 c. Used on Class A and B fires

    2 d. Used on Class B and C fires

    1. Pressurized water
    2. Carbon dioxide (CO_2)
    3. Dry chemical
    4. Soda acid
    5. Foam

13. Complete general shop safety test.

14. Complete safety practice form.

    (NOTE: Activities 13-14 should be evaluated to the satisfaction of the instructor.)

[redacted]

POSITION WELDING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to deposit beads in the flat, horizontal, vertical, and overhead positions using E 6010, E 6011, E 7018 electrodes. The student should be able to construct test plates in all positions that will withstand a root and face bend and tensile test. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with position welding to the correct definitions.
2. List factors that determine proper machine adjustment.
3. Identify welding positions.
4. Select from a list reasons for removing slag from a weld.
5. Describe the importance of fusing one bead with another.
6. List factors that determine weld quality.
7. Identify properly and improperly formed beads.
8. Discuss solutions to prevent arc blow.
9. Label types of groove joints.
10. Identify basic welding symbols used on a drawing.
11. Demonstrate the ability to:
    a. Make a pad in the horizontal position.
    b. Make a multiple pass T-joint fillet weld in the horizontal position.
    c. Make a square groove butt joint weld in the horizontal position.
    d. Make a pad in the vertical up position.
    e. Make a T-joint fillet weld in the vertical up position.

f. Make a square groove butt joint weld in the vertical down position.

g. Make a pad in the overhead position.

h. Make a lap joint fillet weld in the overhead position.

i. Lay out, cut, and prepare test plate.

j. Test the prepared coupon.

k. Make a single V-groove butt joint weld in the flat position and test.

l. Make a single V-groove butt joint weld in the horizontal position and test.

m. Make a single V-groove butt joint weld in the vertical up position and test.

n. Make a single V-groove butt joint weld in the overhead position and test.

POSITION WELDING
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   (NOTE: On each job sheet E-7018 electrodes may be substituted for E-6010.)

   G. Give test.

II. Unit references:

   A. *New Lessons in Arc Welding.* Cleveland, Ohio: The Lincoln Electric Company.

   B. *Hobart Welding School Workbook.* Troy, Ohio: Hobart School of Welding Technology.

   C. *The Welding Encyclopedia.* 16th ed. The Welding Engineer Publishing Company. Morton Grove, Illinois: Monticello Books.

   D. *Welding Handbook.* 6th ed. Miami, Florida: American Welding Society.

   E. Pierre, Ed R. *Welding Processes and Power Sources Study Guide and Workbook.* Appleton, Wisconsin: Miller Electric Manufacturing Company.

   F. *Welding Skills and Practices.* 3rd ed. Chicago, Illinois: American Technical Society.

POSITION WELDING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Pad--Series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer

B. Horizontal position--Running of a horizontal bead on a vertical surface (Transparency 1)

C. Vertical position--Beads are deposited vertically on a vertical surface; axis of the weld is vertical (Transparency 1)

D. Weld face--Exposed surface of a fusion weld

E. Root--Bottom surface of a weld; the opposite side from which the welding was done

F. Penetration--Distance from the original surface of the base metal to that point at which fusion ceases

G. Undercutting--Portion of the crater left unfilled due to excessive current and the improper movement of the electrode; occurs at the edge of the bead (Transparency 5)

H. Crater--Depression in the face of a weld caused by arc force; usually found at the end of a bead

I. Fusion--Melting of metals until the molten parts unite with each other

J. Spatter--Deposit of small spots or particles of metal on the base metal alongside the bead (Transparency 3)

K. Overhead position--Position of welding wherein welding is performed from the underside of the joint (Transparency 1)

L. String bead--Weld bead made with very little rod manipulation

M. Root opening--Gap between the members to be joined at the root of the joint

N. Porosity--Condition caused by a trapped gas pocket in a weld as it solidifies

O. Slag inclusion--Nonmetallic porous material entrapped in weld metal or between the weld metal and base metal

INFORMATION SHEET

  P. Cold lap--Piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld

  Q. Arc blow--Concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path

  R. Coupon--That portion of a weld which is removed from the test plate to test

II. Factors that determine proper machine adjustment

  A. Length of welding cables

  B. Thickness of metal

  C. Diameter and type of electrode

  D. Welding technique used by operator

  E. Efficiency of welding machine

  F. Polarity of machine

  G. Welding position

III. Welding positions (Transparencies 1 and 2)

  A. Flat

  B. Vertical

  C. Overhead

  D. Horizontal

IV. Reasons for removing slag from a weld

  A. Permits better fusion of beads

  B. Prevents gas pockets and slag inclusions from forming in bead

  C. Improves appearance of bead

V. Importance of fusing one bead with another

  A. Increases strength of weld

  B. Improves appearance of weld

  C. Improves penetration

INFORMATION SHEET

VI. Factors that determine weld quality

A. Amperage

B. Length of arc

C. Speed of travel

D. Position of electrode

/II. Properly and improperly formed beads (Transparency 3)

A. Current, voltage, and speed normal

(NOTE: This gives a smooth well-formed bead with no undercutting, overlapping, or piling of slag.)

B. Current too low

(NOTE: This causes poor penetration, slow progress, and excessive piling of weld metal.)

C. Current too high

(NOTE: This causes excessive spatter and undercutting of weld joints.)

D. Voltage too high

(NOTE: This causes poor penetration with flat head. The weld zone is not shielded.)

E. Voltage too low

(NOTE: This causes poor penetration and a wide hamped bead. The electrode is too close to crater, causing porosity.)

F. Speed too slow

(NOTE: This causes excessive heat and piling up of weld metal, leading to unnecessary distortion of joint.)

G. Speed too fast

(NOTE: This causes irregular bead and poor penetration. There is also not enough metal in joint, causing a weak joint.)

INFORMATION SHEET

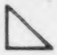
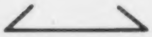
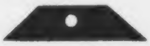
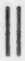
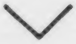
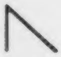
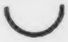
VIII. Solutions to prevent arc blow

- A. Reduce current
- B. Switch polarity
- C. Change current to AC
- D. Change location of ground clamp
- E. Wrap ground cable around workpiece and pass ground current through it to neutralize magnetic field
- F. Maintain a short arc

IX. Types of groove joints (Transparency 4)

- A. Square
- B. J
- C. Single bevel
- D. Single V
- E. Double bevel
- F. U

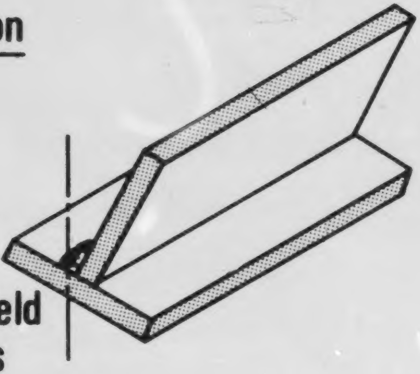
X. Basic welding symbols used on a drawing (Transparency 6)

Weld Type	Symbol
A. Fillet	
B. Plug or slot	
C. Arc seam, arc spot	
D. Butt or square groove	
E. V	
F. Bevel	
G. U	

Weld Test Positions

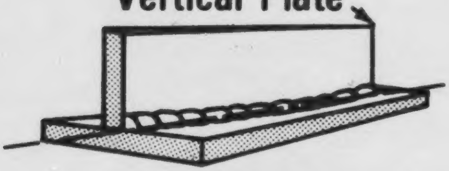
FILLET WELDS

Flat Position



Throat of Weld
Vertical-Axis
of Weld Horizontal

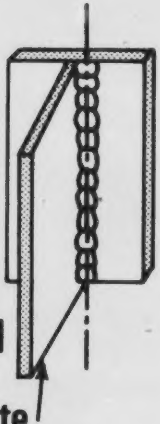
Horizontal Position



Vertical Plate

Axis of Weld Horizontal

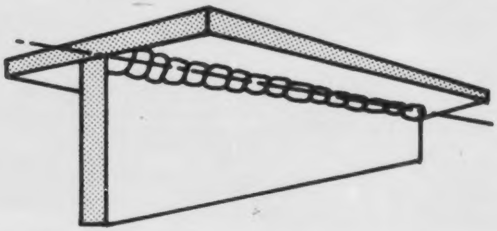
Vertical Position



xis of Weld Vertical

Vertical Plate

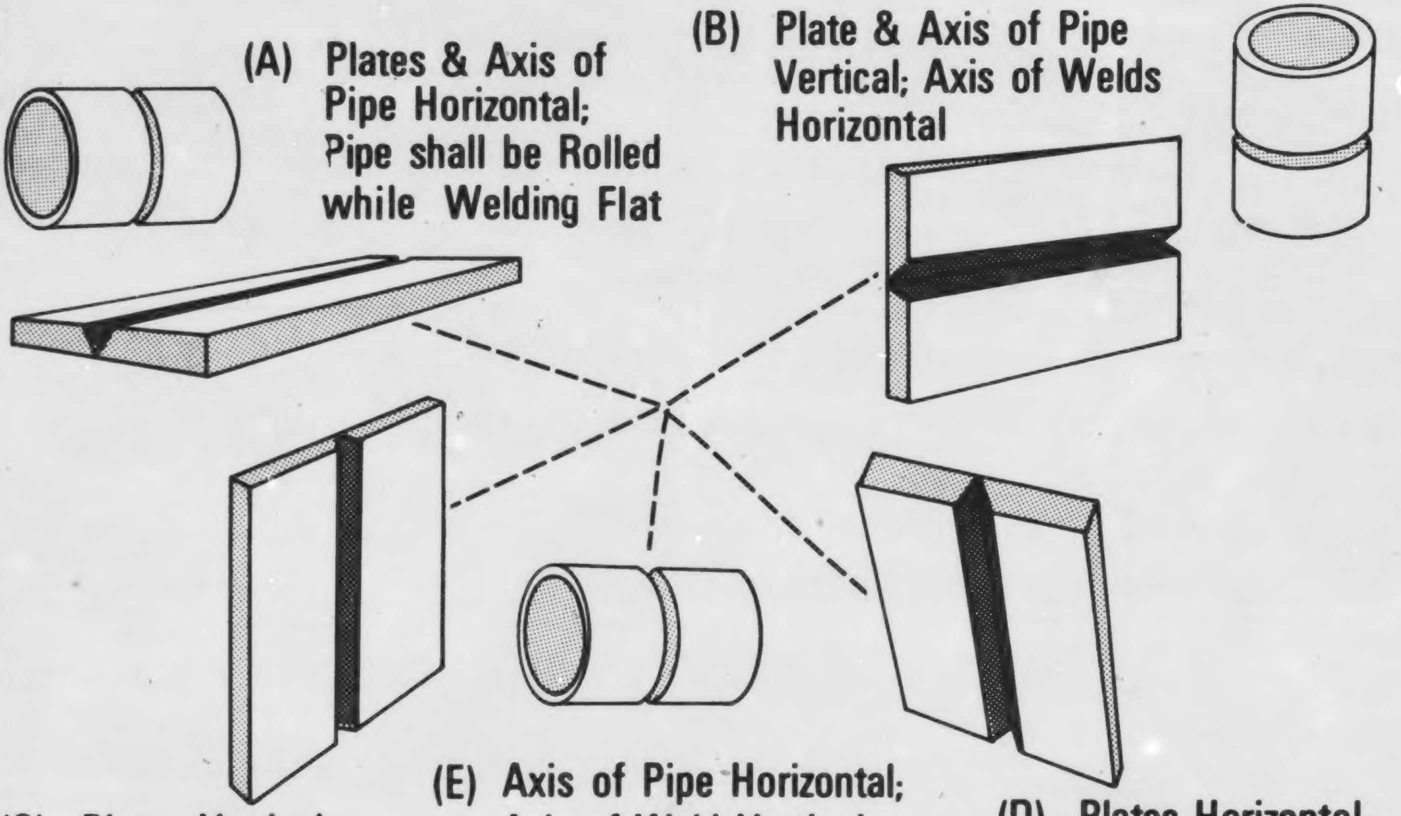
Overhead Position



Vertical Plate
Axis of Weld Horizontal

Weld Test Positions

GROOVE WELDS



(A) Plates & Axis of Pipe Horizontal; Pipe shall be Rolled while Welding Flat

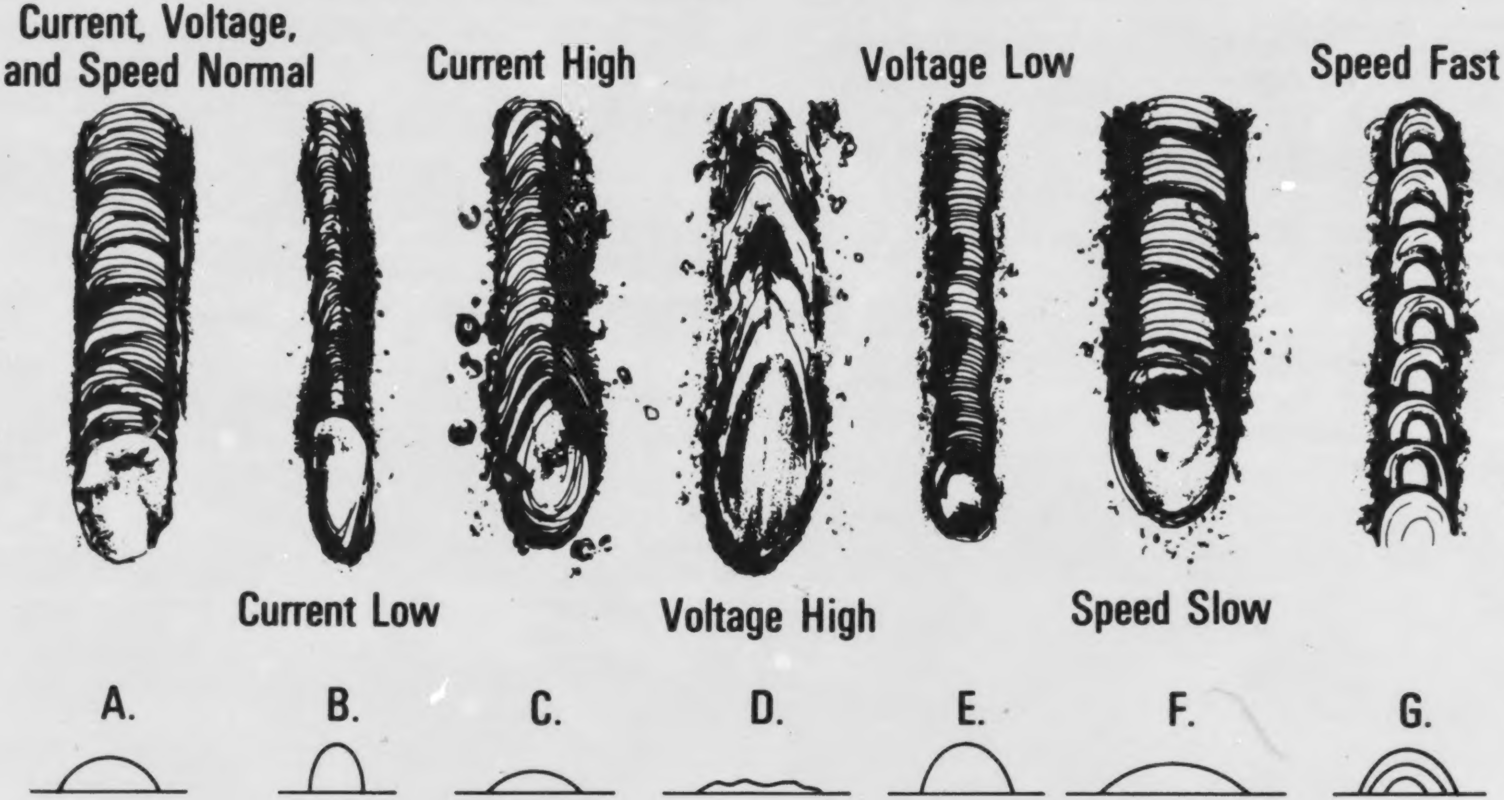
(B) Plate & Axis of Pipe Vertical; Axis of Welds Horizontal

(E) Axis of Pipe Horizontal; Axis of Weld Vertical

(C) Plates Vertical Axis of Weld Vertical

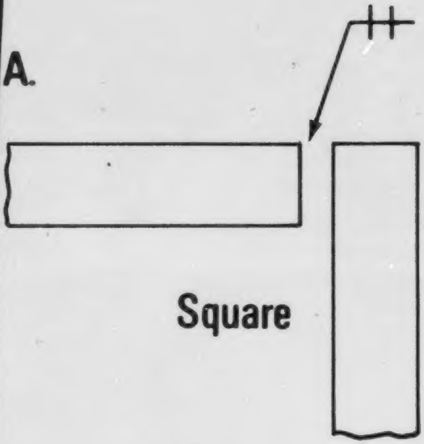
(D) Plates Horizontal; Axis of Weld Horizontal

Properly and Improperly Formed Beads


Current, Voltage, and Speed Normal
Current Low
Current High
Voltage High
Voltage Low
Speed Slow
Speed Fast
A.
B.
C.
D.
E.
F.
G.

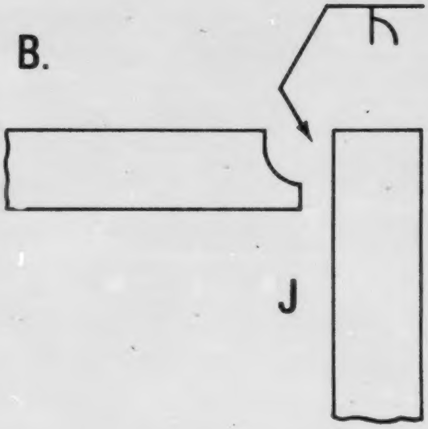
Types of Groove Joints

A.



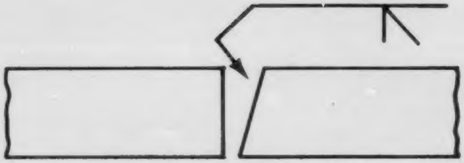
Square

B.



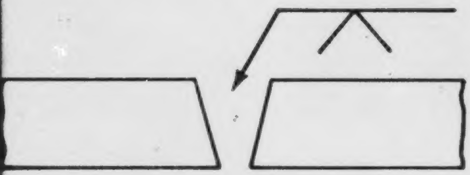
J

C.



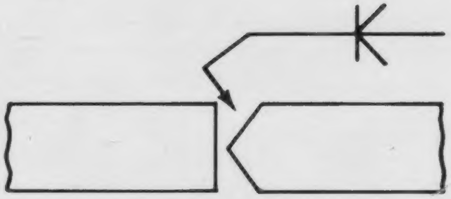
Single Bevel

D.



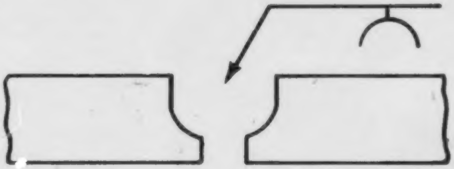
Single V

E.



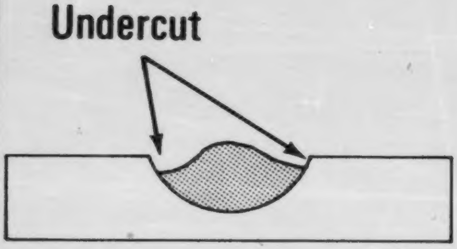
Double Bevel

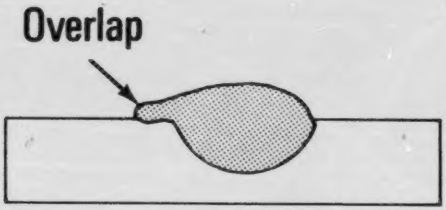
F.

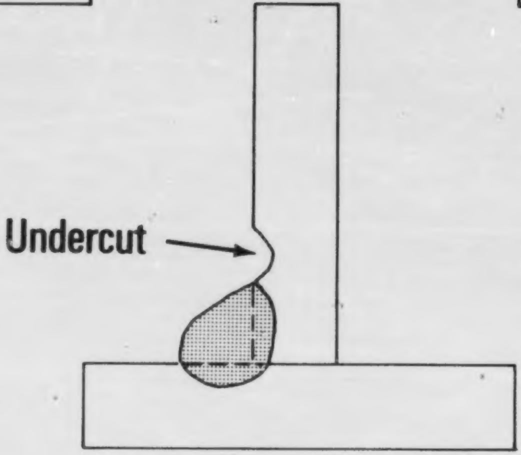


U

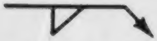
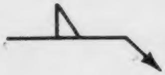
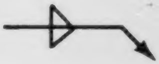
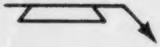
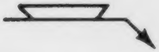
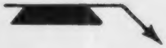
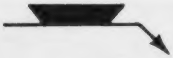
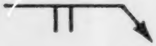
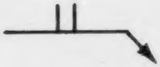
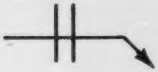
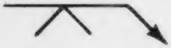
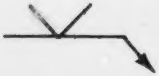
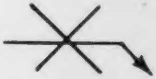
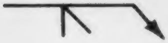
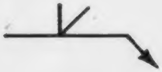
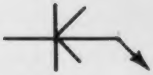
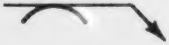
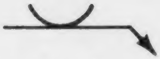
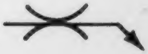
Undercutting and Overlap







Basic Welding Symbols

WELD TYPE	ARROW SIDE	FAR SIDE	BOTH SIDES
Fillet			
Plug or Slot			Not Used
Arc Seam, Arc Spot			Not Used
Butt or Square Groove			
V			
Bevel			
U			

POSITION WELDING
UNIT I

JOB SHEET #1--MAKE A PAD IN THE HORIZONTAL POSITION

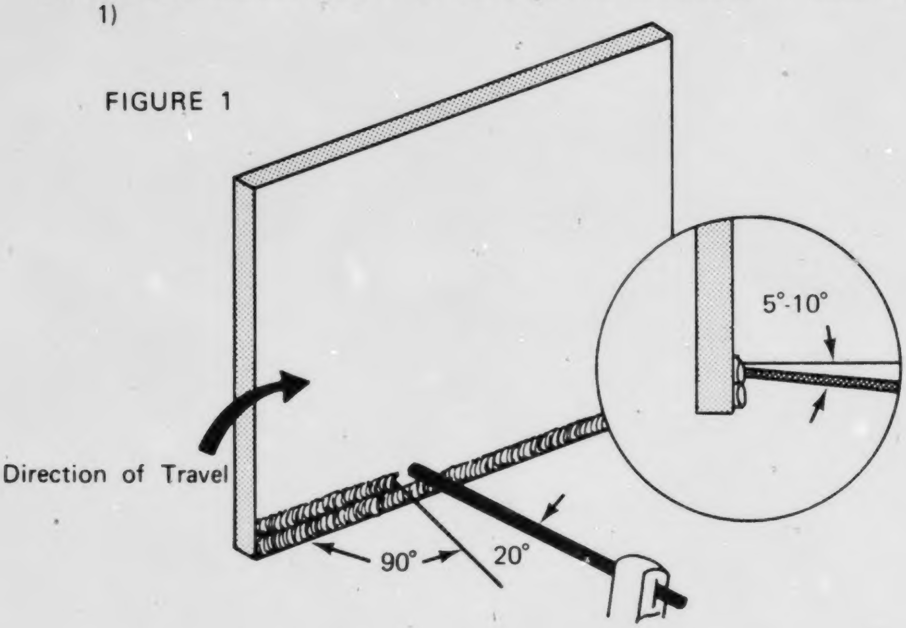
I. Equipment and materials

- A. Arc welding station and required tools
- B. Protective clothing
- C. Electrodes--E-6010, E-6011, or E-7018; 1/8" or 5/32"
  1. 1/8" - 75-130 amps
  2. 5/32" - 90-175 amps
- D. Current DCRP + at electrode
- E. Mild steel plate, 3/8" x 6" x 6"

II. Procedure

- A. Adjust machine to correct type and amount of current
- B. Position metal in horizontal position for welding and tack
- C. Position electrode down 5°-10° and angled 20° in direction of travel (Figure 1)

FIGURE 1



JOB SHEET #1

D. Strike arc and hold high arc length 1-2 seconds in lower left hand corner welding to the lower right hand corner

(NOTE: Some type of manipulation of the rod will be helpful.)

(CAUTION: Care should be taken to hold center of bead 1/8"-3/16" from bottom edge to avoid burning edge off.)

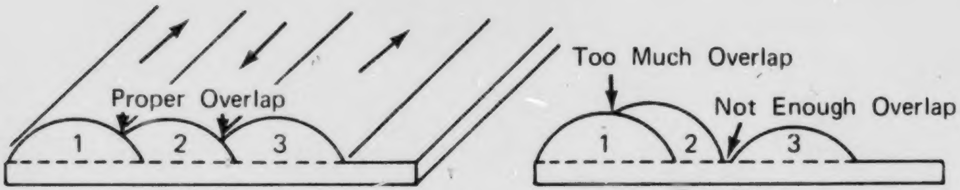
E. Chip and brush weld clean after laying first bead and check weld surface for pinholes and slag inclusions

(NOTE: Crater at end of bead should be filled.)

F. Continue running beads overlapping at the least the first one-third of the previous bead until pad is filled (Figure 2)

(NOTE: Alternate travel direction for each pass.)

FIGURE 2



End View
Proper Bead Lap

End View
Improper Bead Lap

(NOTE: Clean each pass thoroughly before overlapping with another to insure a sound weld deposit with proper penetration. Each pass should fuse with the base metal as well as with the preceding pass.)

G. Clean the pad

(NOTE: Turn pad in for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #2--MAKE A MULTIPLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel plate, 2 pieces, 1/4" - 3/8" x 3" x 6"

   C. Electrode--E-6010; 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at electrode

   E. Protective clothing

II. Procedure

   A. Adjust welding machine to correct current and amperage

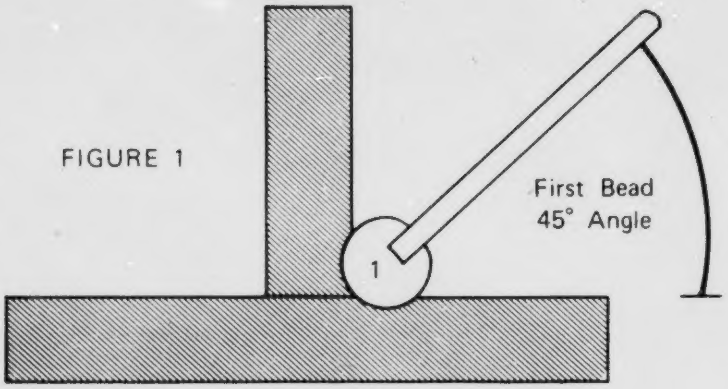
   B. Position plates on table to form a T-joint

   C. Tack plates on each end and slag

   D. Angle electrode 45° from vertical plate and 5°-10° in direction of travel for first bead (Figure 1)

Multiple Pass Fillet Weld

FIGURE 1



JOB SHEET #2

E. Strike arc at end of plate holding a high arc for 1-2 seconds

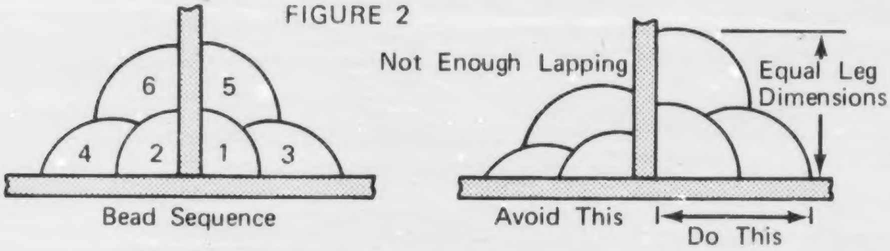
(NOTE: This allows for the end of the metal plates to heat prior to depositing the proper beads and prevents cold lap.)

F. Move electrode to opposite side of T-joint and start depositing second bead using same angle used in bead one

G. Deposit beads about two times wider than electrode diameter

(NOTE: Remember to alternate passes from one side to another of T-joint to minimize distortion of the plates. See Figure 2.)

FIGURE 2



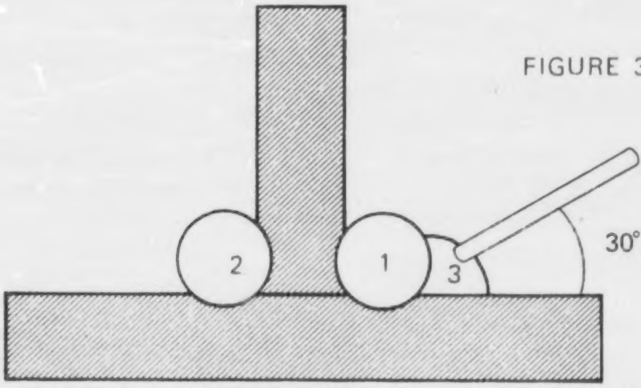
Keep Bead Dimensions Constant

H. Remove slag from beads one and two

(NOTE: Keep each bead dimension constant. It is necessary to overlap beads more than seems necessary to avoid laying too much metal on bottom by side of joint.)

I. Deposit bead three using a 30° degree angle from vertical plate with the electrode slanting 5°-10° in direction of travel (Figure 3)

FIGURE 3



Deposit Beads on Alternate Sides to Minimize Distortion

JOB SHEET #2

J. Deposit bead four using same angle as used in depositing bead three (Figure 4)

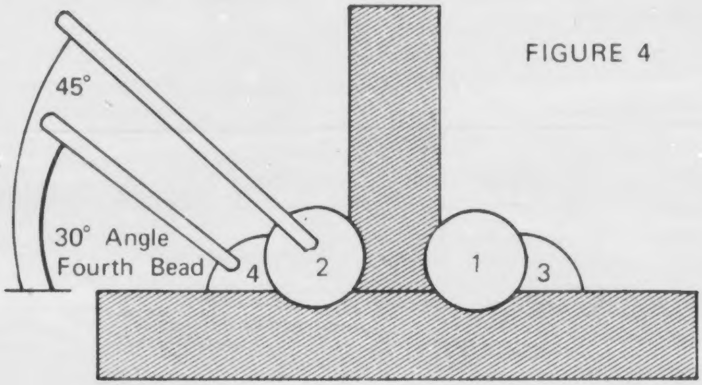

45°
30° Angle
Fourth Bead
4
2
1
3

FIGURE 4

K. Deposit bead five using a 70° degree angle from vertical plate with the electrode slanting 5°-10° in direction of travel (Figure 5)

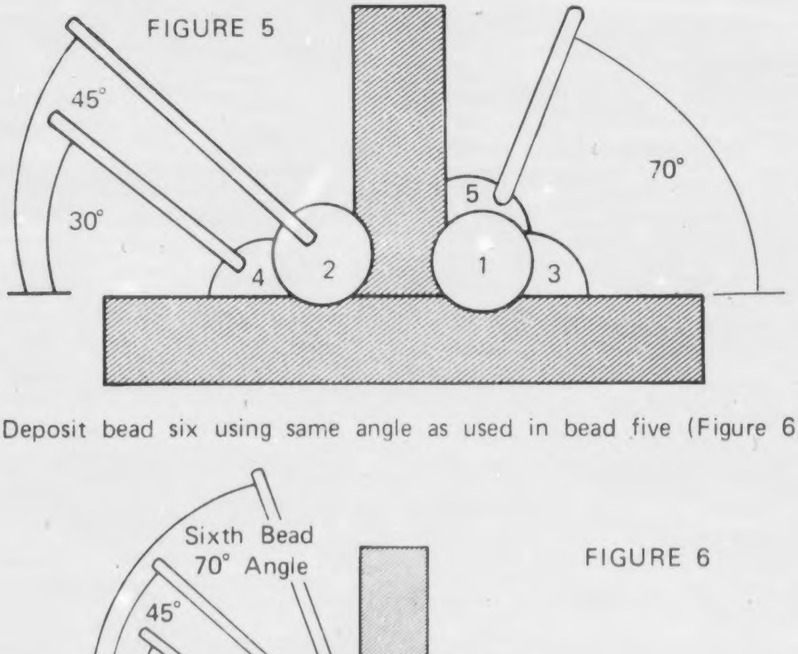

45°
30°
4
2
5
1
3
70°

FIGURE 5

L. Deposit bead six using same angle as used in bead five (Figure 6)

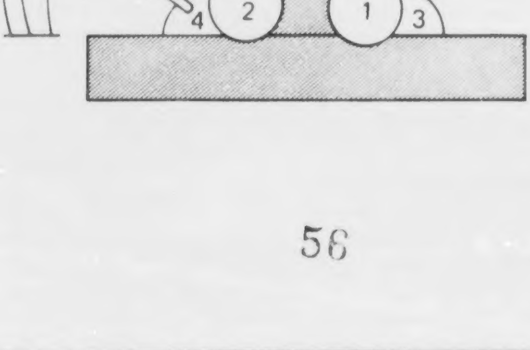

Sixth Bead
70° Angle
45°
30°
6
4
2
5
1
3

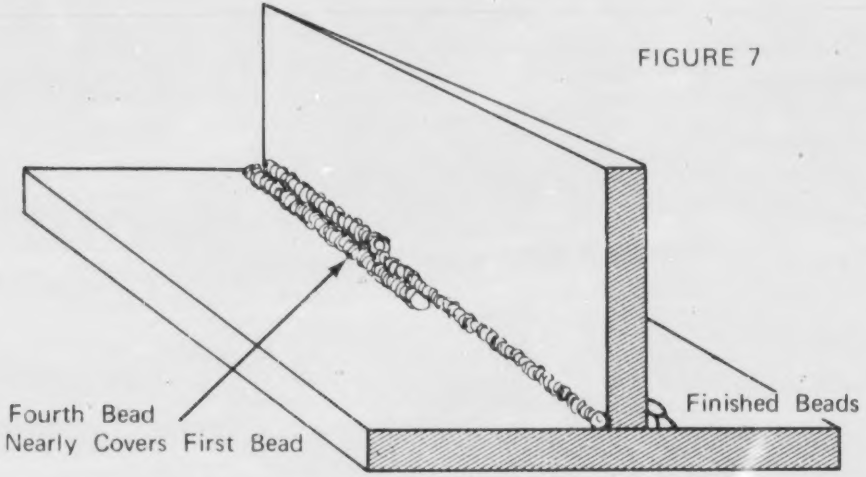
FIGURE 6

JOB SHEET #2

M. Complete required number of passes (Figure 7)

(NOTE: Turn plate in for instructor's approval.)

FIGURE 7


Fourth Bead
Nearly Covers First Bead
Finished Beads

POSITION WELDING
UNIT I

JOB SHEET #3--MAKE A SQUARE GROOVE BUTT JOINT WELD IN THE HORIZONTAL POSITION

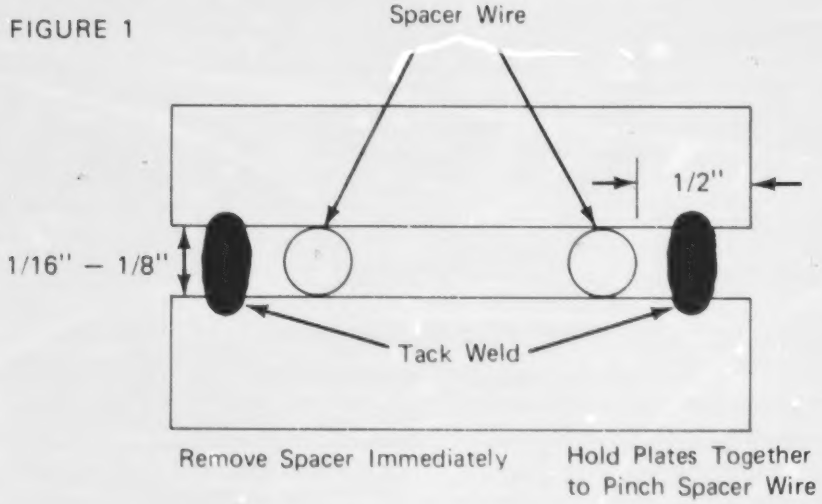
I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plate, 2 pieces, 3/16" x 2" x 6"
- C. Electrode--E-6010; 1/8" or 5/32"
    - 1. 1/8" - 75-130 amps
    - 2. 5/32" - 90-175 amps
- D. Current DCRP + at electrode
- E. Protective clothing

II. Procedure

- A. Adjust machine to correct current and amperage setting
- B. Position material horizontally and tack weld leaving a 1/16" - 1/8" groove (root gap) between plates (Figure 1)

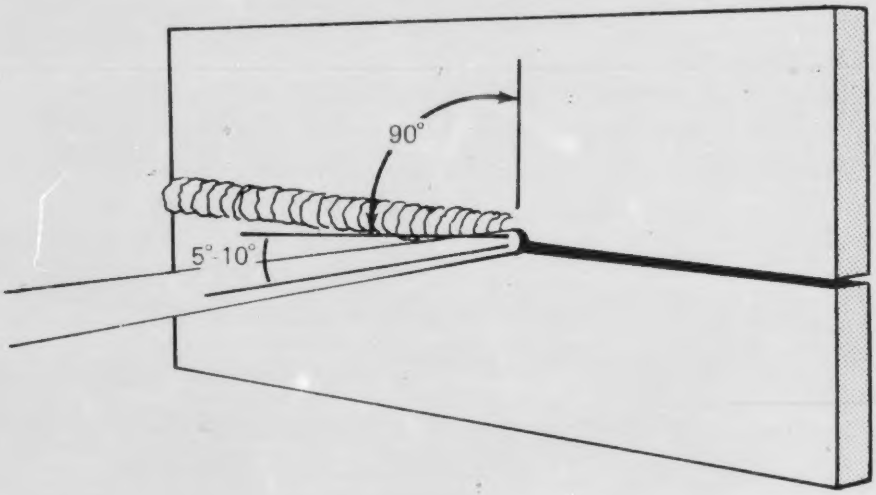
FIGURE 1


Spacer Wire
1/2"
1/16" — 1/8"
Tack Weld
Remove Spacer Immediately
Hold Plates Together to Pinch Spacer Wire

JOB SHEET #3

C. Angle electrode straight into joint 90° with both plates and tilted 5° - 10° in direction of travel (Figure 2)

FIGURE 2



D. Strike and hold a high arc for 1-2 seconds to heat plates

E. Deposit bead using a short arc, burning electrode into joint about 1/3 thickness of material (Figure 3)

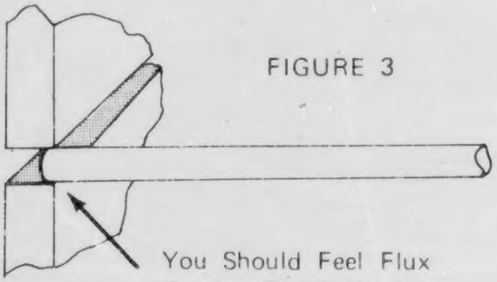


FIGURE 3

(NOTE: Some type of manipulation will be necessary to control puddle and penetration. Movement of the wrist rather than the arm aids in controlling electrode motions.)

F. Check root of weld on reverse side to determine extent of penetration (should be 100%); remove all slag and deposit a second bead on reverse side

G. Clean plate

(NOTE: Turn plate in for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #4--MAKE A PAD IN THE VERTICAL UP POSITION

I. Equipment and materials

A. Arc welding station and required tools

B. Mild steel plate, 3/8" x 6" x 6"

C. Electrode--E-6010; 1/8" or 5/32"

1. 1/8" - 75-130 amps

2. 5/32" - 90-175 amps

D. Current DCRP + at 1/8" electrode, 75-130 amps

E. Protective clothing

II. Procedure

A. Adjust machine to correct type and amount of current

B. Prepare and tack metal in a vertical position

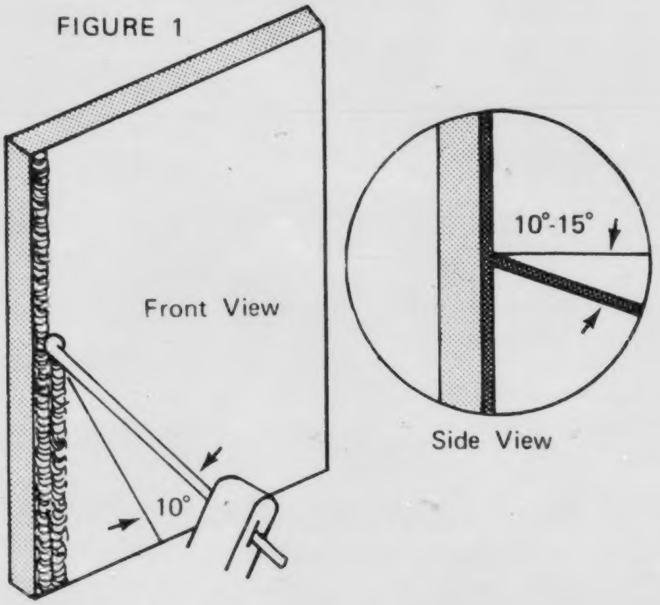
(NOTE: Vertical up welding has deeper penetration than the vertical down; this technique is usually reserved for thicker metals and requires lower amperage settings.)

C. Position electrode at 90° angle to plate and tip down from horizontal 10°-15° for first bead

JOB SHEET #4

D. Make sure all other beads are at 10° side angle with each previously laid bead with the 10°-15° angle down from horizontal remaining the same (Figure I)

FIGURE 1


Front View
10°
10°-15°
Side View

E. Strike an arc on the lower left hand corner of plate; hold high arc length 1-2 seconds and start welding upward to top of plate

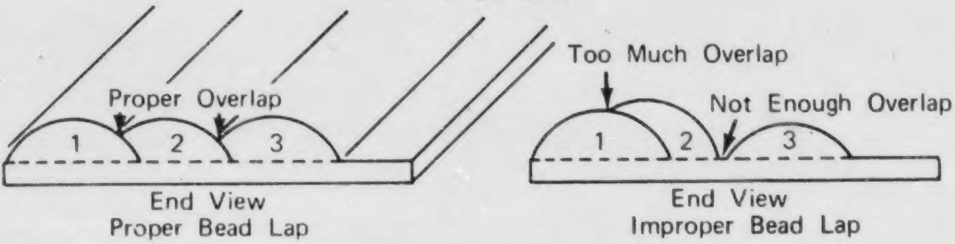
(NOTE: A slight manipulation of the rod tip will be necessary.)

F. Chip and brush weld clean after laying first bead and check surface for porosity and slag inclusions

(NOTE: Crater at end of each pass should be filled.)

G. Deposit additional beads, overlapping each at least 1/3 until pad is filled (Figure 2)

FIGURE 2


Proper Overlap
1
2
3
End View
Proper Bead Lap
Too Much Overlap
Not Enough Overlap
1
2
3
End View
Improper Bead Lap

H. Apply complete layer of passes and clean thoroughly

(NOTE: Turn in to instructor for evaluation.)

POSITION WELDING
UNIT I

JOB SHEET #5--MAKE A T-JOINT FILLET WELD IN THE VERTICAL UP POSITION

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel plate, 2 pieces, 1/4" - 3/8" x 2" x 6"

   C. Electrode--E-6010; 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at 1/8" electrode, 75-130 amps

   E. Protective clothing

II. Procedure

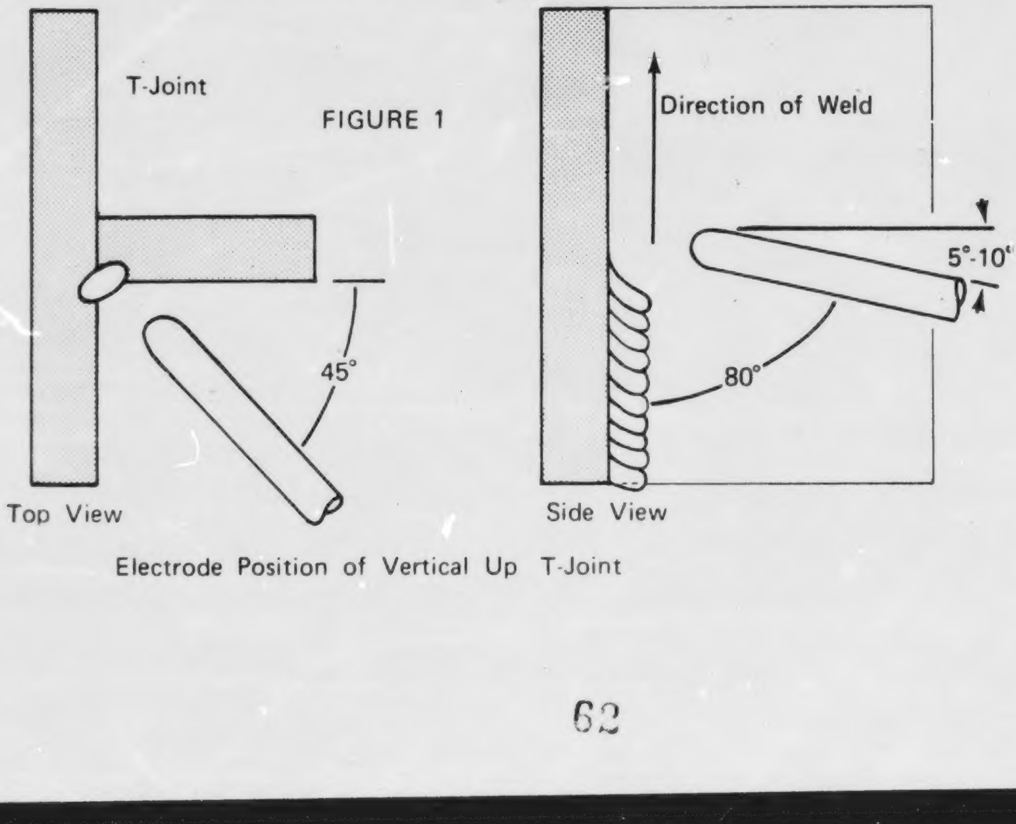
   A. Adjust welding machine to correct current and amperage setting

   B. Prepare and tack metal in vertical position

   C. Strike arc at bottom of joint and hold a high arc length for 1-2 seconds to heat plates

   D. Position electrode in middle of joint making a 45° angle with each plate and 5°-10° down from horizontal (Figure 1)

FIGURE 1



Electrode Position of Vertical Up T-Joint

JOB SHEET #5

E. Deposit weld upward using some form of up and down whipping motion

(NOTE: Bead uniformity depends upon proper timing and manipulation of electrode. Check with instructor for correct procedures.)

F. Remove slag and clean thoroughly after every pass

G. Alter sides to minimize distortion

(NOTE: Check with instructor at this point. Upon receiving instructor's approval, additional beads may be stringers or some form of weave bead.)

H. Complete exercise

(NOTE: Turn in plate for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #6--MAKE A SQUARE GROOVE BUTT JOINT WELD IN THE VERTICAL DOWN POSITION

I. Equipment and materials

A. Arc welding station and required tools

B. Mild steel plate, 2 pieces, 1/8" - 3/16" x 3" x 6"

C. Electrode--E-6010; 1/8" or 5/32"

1. 1/8" - 75-130 amps

2. 5/32" - 90-175 amps

D. Current DCRP + at the electrode

E. Protective clothing

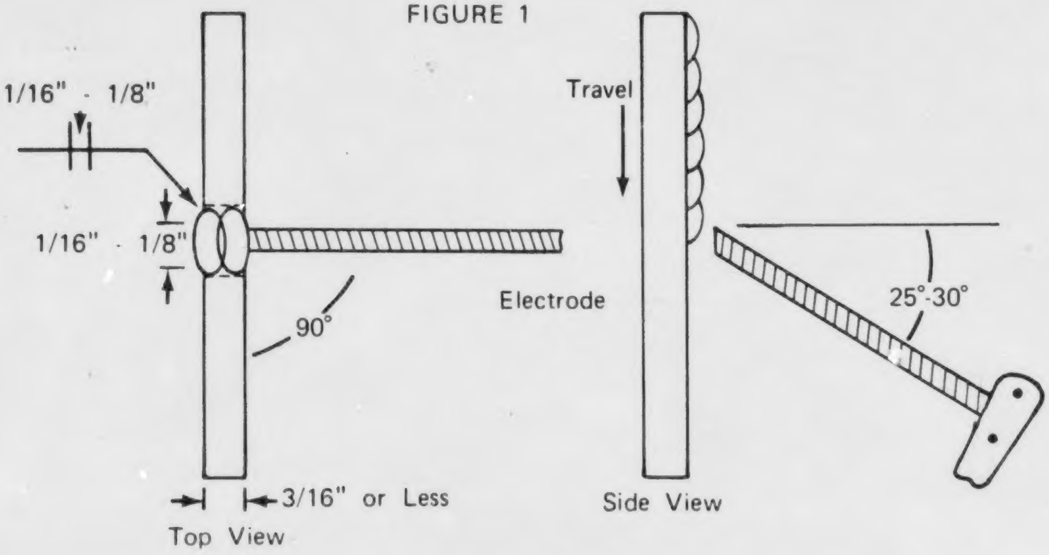
II. Procedure

A. Adjust welding machine to correct current and amperage setting

B. Prepare and tack metal leaving a 1/6" - 1/8" root gap in vertical position

C. Position electrode straight into middle of joint and down 25° - 30° from horizontal (Figure 1)

FIGURE 1


1/16" - 1/8"
1/16" - 1/8"
90°
3/16" or Less
Top View
Travel
Electrode
25°-30°
Side View

JOB SHEET #6

D. Strike arc at top of plates; hold a high arc length for 1-2 seconds to heat plates and prevent cold laps

E. Weld down holding a short arc length with some form of whipping motion

F. Remove all slag from face and root and inspect bead thoroughly for penetration and even fusion with both plates

G. Start at the top of the reverse side and run second bead using the same technique as in first pass

H. Clean and inspect

(NOTE: Turn in for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #7--MAKE A PAD IN THE OVERHEAD POSITION

I. Equipment and materials

A. Arc welding station and required tools

B. Mild steel plate, 1/4" - 3/8" x 6" x 6"

C. Electrode--E-6010; 1/8" or 5/32"

1. 1/8" - 75-130 amps

2. 5/32" - 90-175 amps

D. Protective clothing

II. Procedure

A. Adjust welding machine to correct current and amperage setting

B. Prepare and tack metal in the overhead position

(NOTE: Metal will be in horizontal position with floor.)

C. Strike arc at edge of plate; hold a high arc for one or two seconds to heat up base metal

(CAUTION: Avoid depositing first bead too close to edge of plate.)

D. Hold electrode perpendicular to plate with a 0°-15° in direction of travel (Figure I)

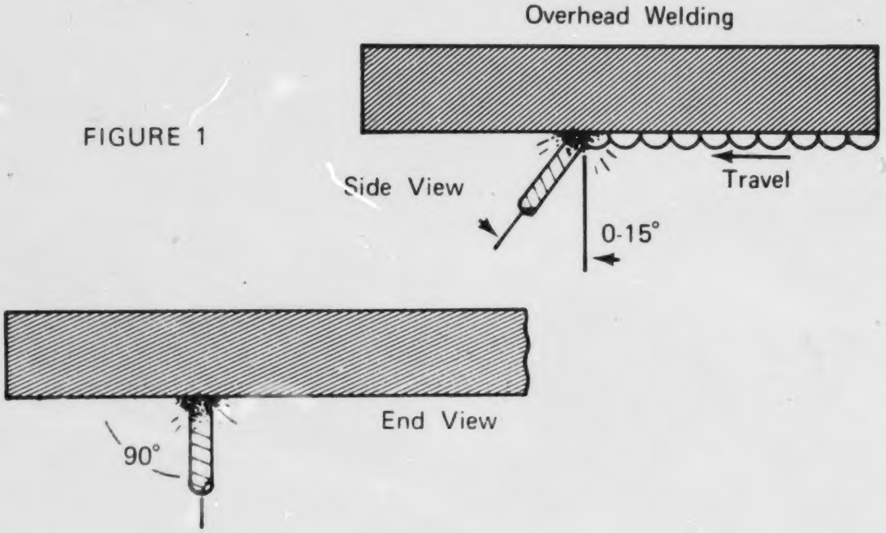


FIGURE 1

JOB SHEET #7

(NOTE: Metal should be deposited with a very short arc. A slight whipping motion may be helpful in controlling bead shape.)

E. Start at the end of plate and progress across plate

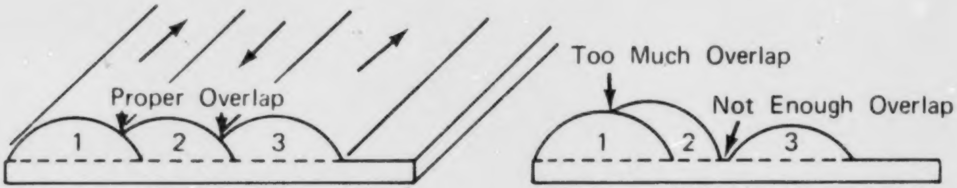
(NOTE: After completion of each bead, thoroughly chip and brush the weld checking for bead appearance which will determine if current, amps, or welding technique need to be changed.)

F. Deposit additional beads until plate is completely covered

(NOTE: Each additional bead should be overlapped about 1/3 of previous bead. Bead should have a smooth surface without noticeable "valleys" or "trapped slag." See Figure 2. Alternate travel direction for each pass.)

(NOTE: Alternate travel direction for each pass.)

FIGURE 2



End View
Proper Bead Lap

End View
Improper Bead Lap

G. Complete the required layer of passes and clean pad

(NOTE: Turn in for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #8--MAKE A LAP JOINT FILLET WELD IN THE OVERHEAD POSITION

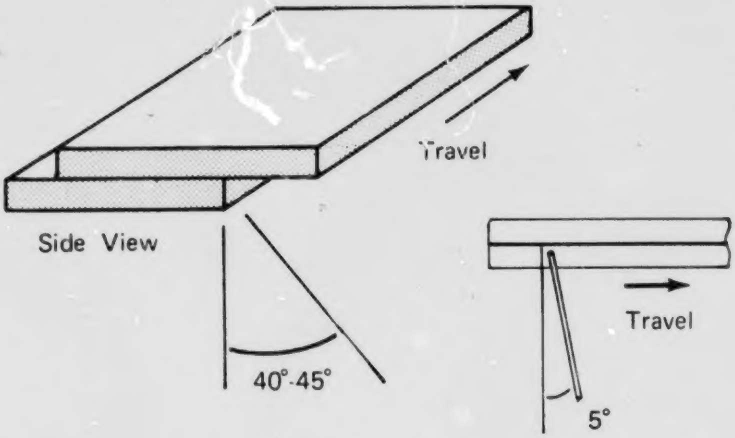
I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plate, 2 pieces, 1/4" - 3/8" x 2" x 6"
- C. Electrode--E-6010; 1/8" or 5/32"
  - 1. 1/8" - 75-130 amps
  - 2. 5/32" - 90-175 amps
- D. Current DCRP + at electrode
- E. Protective clothing

II. Procedure

- A. Adjust welding machine to correct current and amperage setting
- B. Prepare and tack plate together for a 90° lap joint in the overhead position
- C. Position electrode 40°-45° out from vertical and inclined 5° in direction of travel (Figure 1)

FIGURE 1



JOB SHEET #8

D. Strike arc and establish a puddle evenly on both pieces

(NOTE: Be sure to get good penetration into root of joint without undercutting or overlapping plates. Some form of whipping motion will be needed.)

E. Chip, brush clean, and check for bead appearance after depositing first bead

F. Deposit additional beads if necessary as stringers or weaves

G. Clean plates

(NOTE: Turn in for instructor's approval.)

POSITION WELDING
UNIT I

JOB SHEET #9--LAY OUT, CUT, AND PREPARE TEST PLATE

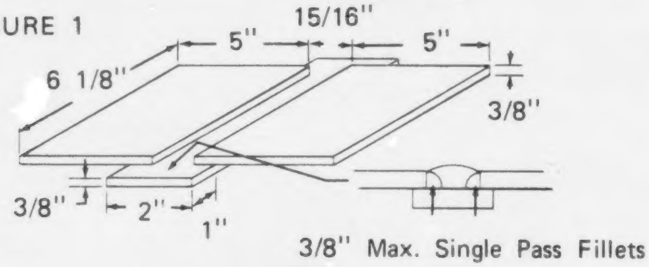
I. Equipment and materials

- A. Soapstone
- B. Steel rule
- C. Power hacksaw
- D. Milling machine (if available)
- E. Oxyacetylene cutting unit
- F. Grinder, portable right angle and pedestal
- G. Protective equipment

II. Procedure

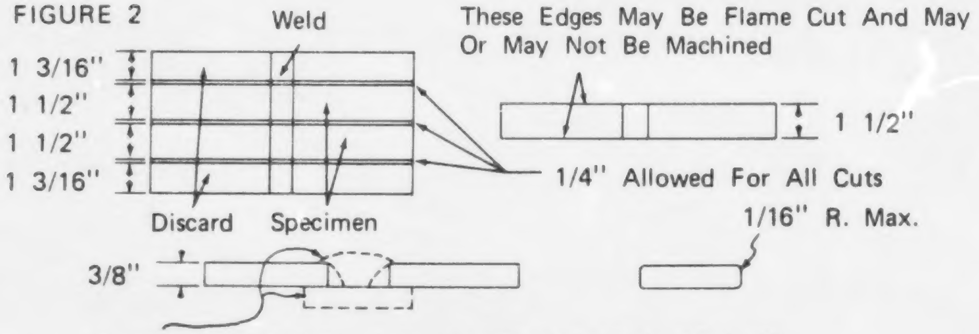
- A. Lay out test plate (Figure 1)

FIGURE 1


15/16"
5"
5"
6 1/8"
3/8"
3/8"
2"
1"
3/8" Max. Single Pass Fillets

- B. Lay out and prepare weld specimens (Figure 2)

FIGURE 2


Weld
These Edges May Be Flame Cut And May Or May Not Be Machined
1 3/16"
1 1/2"
1 1/2"
1 3/16"
1 1/2"
1/4" Allowed For All Cuts
Discard
Specimen
1/16" R. Max.
3/8"

Remove Weld Reinforcement And Backing Strip Flush With Base Metal. Flame Cutting May Be Used, Provided At Least 1/8" Of Its Thickness Is Left To Be Removed By Machining Or Grinding.

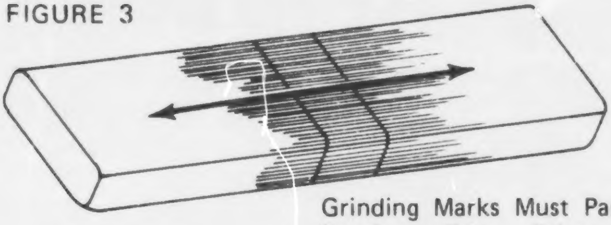
JOB SHEET #9

C. Finish weld coupon or specimen

1. Grind to a smooth flush finish

   (NOTE: Grind marks should run the length of the coupon, not across. See Figure 3.)

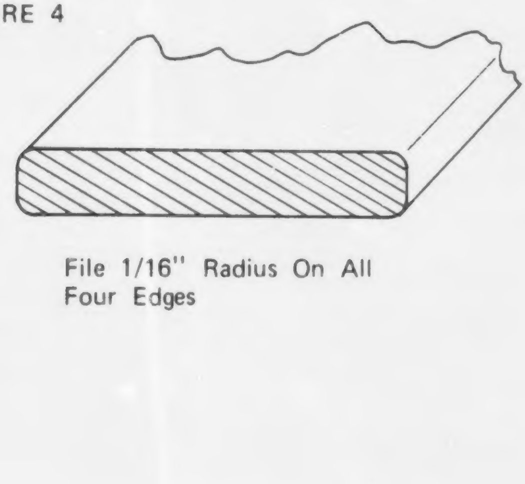
   FIGURE 3

   Grinding Marks Must Parallel Specimen Edges. Otherwise They May Have A Notch Effect Which Could Cause Failure.

2. Grind a slight radius on all four corners running the full length of the coupon (Figure 4)

   FIGURE 4

   File 1/16" Radius On All Four Edges

POSITION WELDING
UNIT I

JOB SHEET #10--TEST THE PREPARED COUPON

I. Equipment and materials

A. Guided bend testing machine

(NOTE: This is the most common type of weld testing equipment used for root and face bend tests.)

B. Tensile testing machine

(NOTE: This is used for tensile tests.)

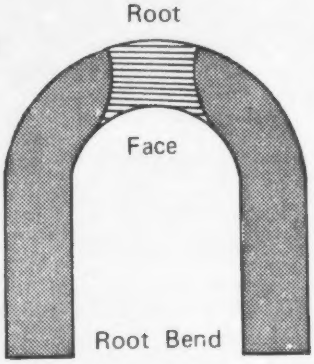
II. Procedure

A. Place prepared coupon in testing machine as instructed

(NOTE: Do not use testing machine unless instructor is present.)

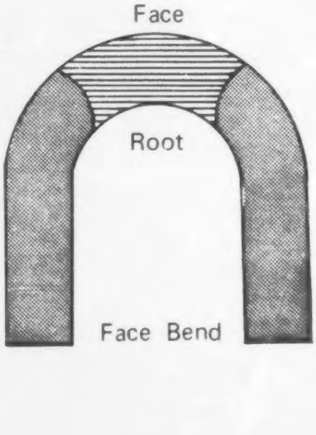
B. Make a root bend with root side up (Figure 1)

FIGURE 1



C. Make a face bend with face side up (Figure 2)

FIGURE 2



JOB SHEET #10

D. Make a tensile test

(NOTE: Check with instructor for proper procedures.)

(CAUTION: Extreme care should be taken when setting up specimen to prevent metal from flying out of testing machine.)

E. Check for standard of acceptability

CONTOUR:	The exposed face of the weld shall be reasonably smooth and regular. There shall be no overlapping or undercutting.
EXTENT OF FUSION:	There shall be complete fusion between the weld and base metal and full penetration to the root of the weld.
SOUNDNESS:	The weld shall contain no gas pocket, oxide particle, or slag inclusion exceeding 1/8" in greatest dimension. In addition, no square inch of weld metal area shall contain more than 6 gas pockets exceeding 1/16" in greatest dimension.
REDUCED-SECTION TENSION TEST:	The tensile strength shall not be less than 100% of the minimum of the specified tensile range of the base material used.

POSITION WELDING
UNIT I

JOB SHEET #11-MAKE A SINGLE V-GROOVE BUTT JOINT WELD IN FLAT POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel plate, 2 pieces, 3/8" x 5" x 6"

   C. Electrode--E 6010; 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at the electrode

   E. Protective clothing

II. Procedure

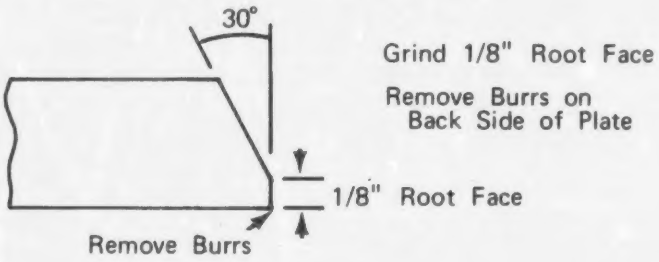
   A. Adjust welding machine for correct current and amperage settings

   B. Prepare metal for welding

      1. Bevel edges of plates 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate


30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

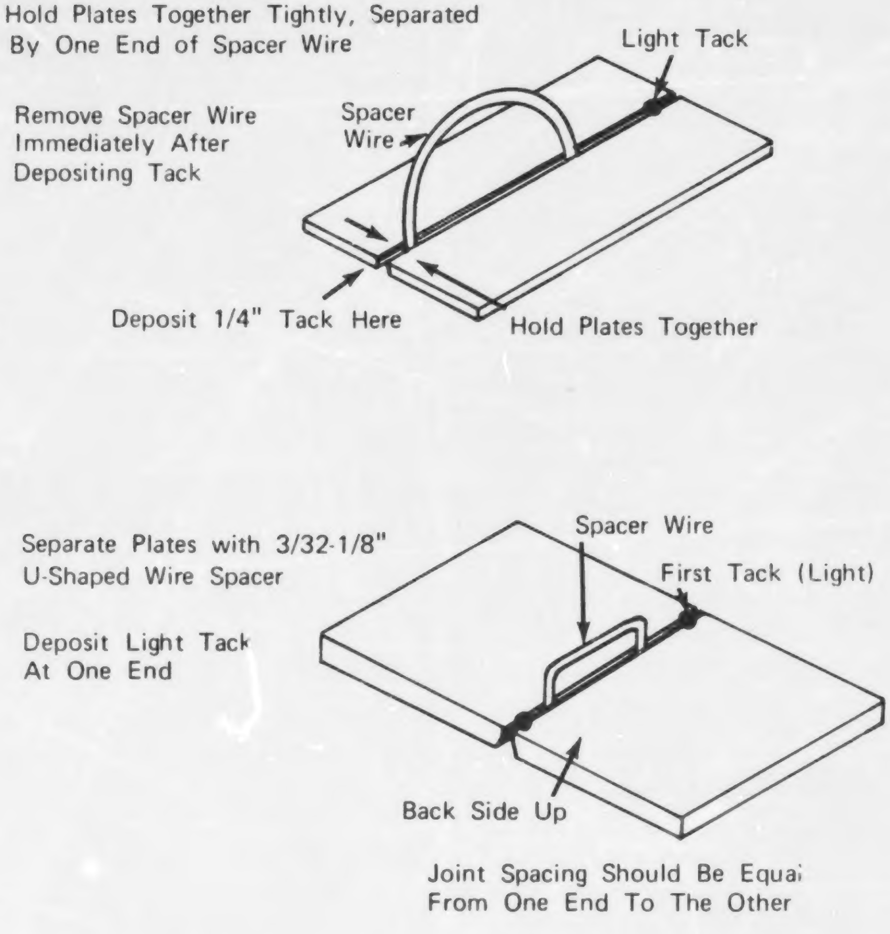
      2. Remove all burrs and slag

JOB SHEET #11

C. Place metal together parallel to each other leaving a root gap from 3/32" to 1/8" in flat position (Figure 2)

(NOTE: Tack weld to prevent distortion.)

FIGURE 2


Hold Plates Together Tightly, Separated By One End of Spacer Wire
Light Tack
Remove Spacer Wire Immediately After Depositing Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Separate Plates with 3/32-1/8" U-Shaped Wire Spacer
Spacer Wire
First Tack (Light)
Deposit Light Tack At One End
Back Side Up
Joint Spacing Should Be Equal From One End To The Other

D. Tack pieces together at both ends and feather tack with a right angle grinder

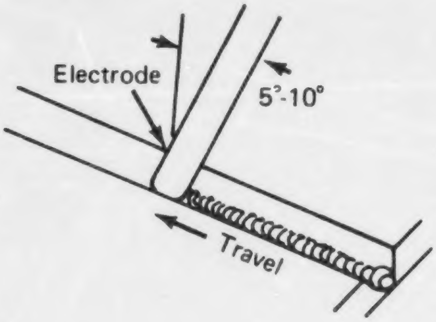
(NOTE: Place a strip of metal under each piece to hold it off table top when welding.)

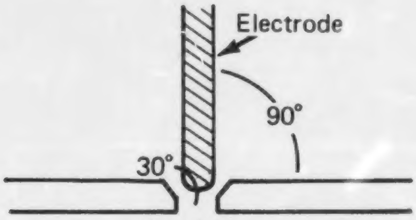
JOB SHEET #11

E. Position electrode straight into plate and angle 5°-10° away from weld puddle (Figure 3)

FIGURE 3

Deposit First Bead





End View

Hold Electrode in Vertical Position. Angle Electrode Away from Weld Puddle 5°-10°. Travel from Right to Left. Penetrate Joint Completely.

F. Strike high arc length to heat plates, then move to end and weld plates together using a stringer bead

(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate. See Figure 4.)

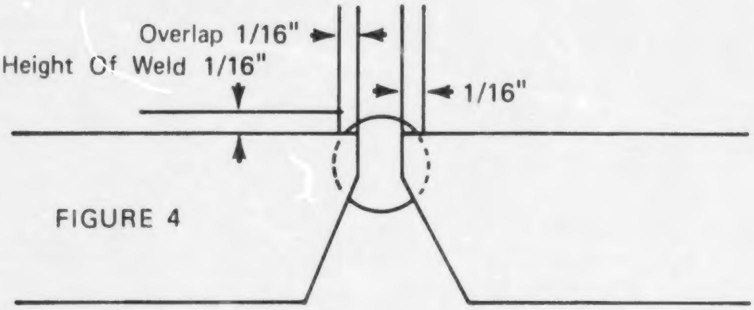


FIGURE 4

(CAUTION: Avoid undercutting faces of groove.)

G. Chip slag and brush weld clean

JOB SHEET #11

H. Deposit necessary filler passes to fill out the V, using care to remove all slag deposits between each pass

(NOTE: Filler passes can be stringers or weaves.)

I. Make cover pass or passes slightly convex overlapping edge of groove 1/16" on each side

J. Cut and prepare two coupons out of this weld

K. Cool plates slowly

(CAUTION: Do not place plates in water.)

(NOTE: Turn in plate to instructor for testing.)

POSITION WELDING
UNIT I

JOB SHEET #12--MAKE A SINGLE V-GROOVE BUTT JOINT WELD IN THE HORIZONTAL POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

  A. Arc welding station and required tools

  B. Mild steel plate, 2 pieces, 3/8" x 5" x 6"

  C. Electrode--E-6010; 1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  D. Current DCRP + at the electrode

  E. Protective clothing

II. Procedure

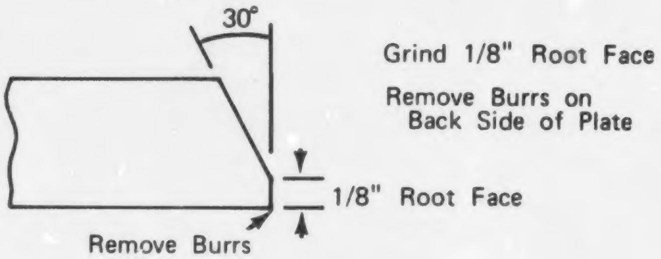
  A. Adjust welding machine for correct current and amperage settings

  B. Prepare plates for welding

    1. Bevel each plate 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate


30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

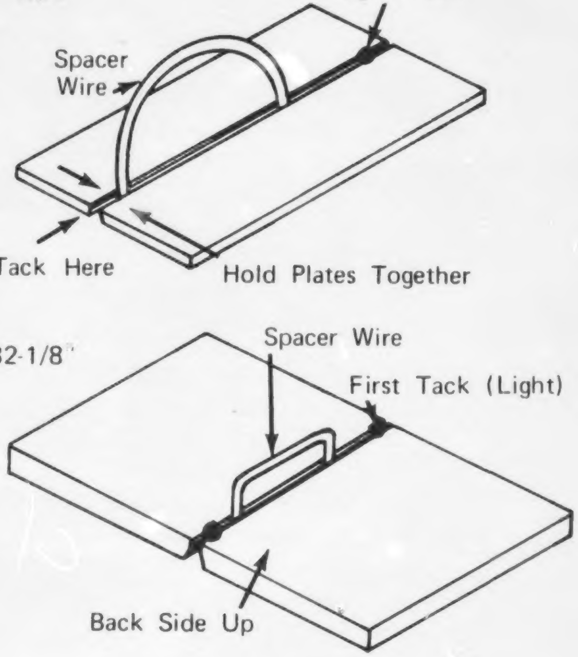
    2. Remove all burrs and slag if flame cut

  C. Tack plates together leaving a root gap of 3/32" - 1/8" slag and feather tacks

JOB SHEET #12

D. Position plates vertically as shown (Figure 2)

(NOTE: Tack weld on both sides to prevent distortion.)


Light Tack
Spacer Wire
Spacer Wire
First Tack (Light)
Back Side Up

Hold Plates Together Tightly, Separated By One End of Spacer Wire

Remove Spacer Wire Immediately After Depositing Tack

FIGURE 2

Deposit 1/4" Tack Here

Hold Plates Together

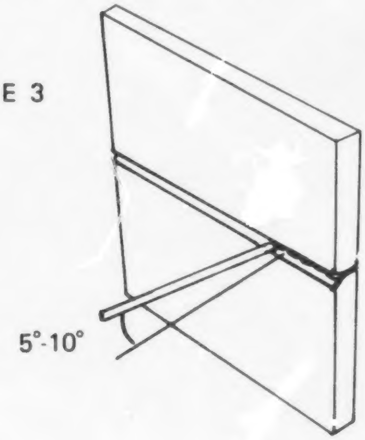
Separate Plates with 3/32-1/8" U-Shaped Wire Spacer

Deposit Light Tack At One End

Joint Spacing Should Be Equal From One End To The Other

E. Hold electrode 90° or straight into joint tilting 5°-10° in direction of travel (Figure 3)

FIGURE 3



JOB SHEET #12

F. Strike arc and hold high arc length to heat plates and use root pass

(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate. See Figure 4.)

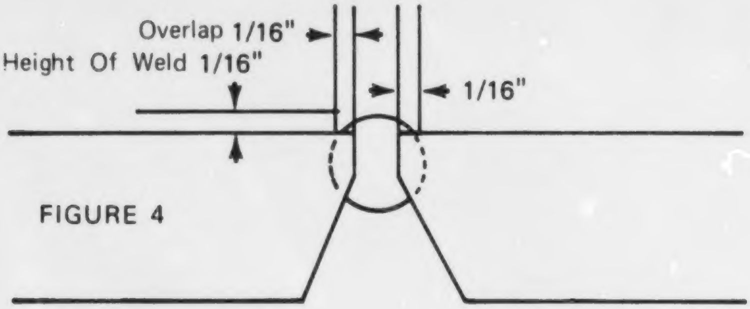


FIGURE 4

G. Chip slag and brush weld clean after each pass

H. Deposit additional welds as stringers or weaves (as determined by instructor)

I. Make cover pass or passes slightly convex and overlapping top edge of groove 1/16" on each side

J. Cut and prepare coupons

K. Cool plate in still air slowly

(CAUTION: Do not cool in water.)

L. Test coupons

POSITION WELDING
UNIT I

JOB SHEET #13--MAKE A SINGLE V-GROOVE BUTT JOINT WELD IN THE VERTICAL UP POSITION AND TEST

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel plate, 2 pieces, 3/8" x 5" x 6"

   C. Electrode--E-6010; 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at the electrode

   E. Protective clothing

II. Procedure

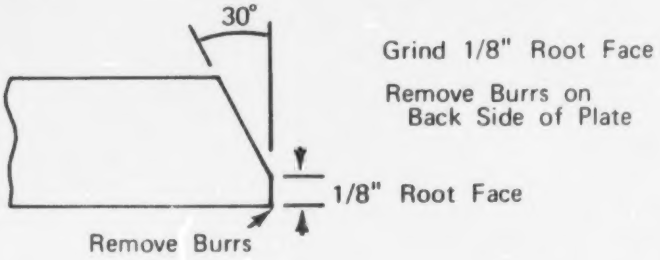
   A. Adjust welding machine for correct current and amperage settings

      (NOTE: Vertical up requires less amperage than flat and horizontal welding.)

   B. Prepare plates for welding (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate


30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

      1. Bevel each plate 30°

      2. Remove all burrs and slag if flame cut

JOB SHEET #13

3. Tack plates together leaving a 3/32" - 1/8" root gap (Figure 2)

Hold Plates Together Tightly, Separated By One End of Spacer Wire

Remove Spacer Wire Immediately After Depositing Tack

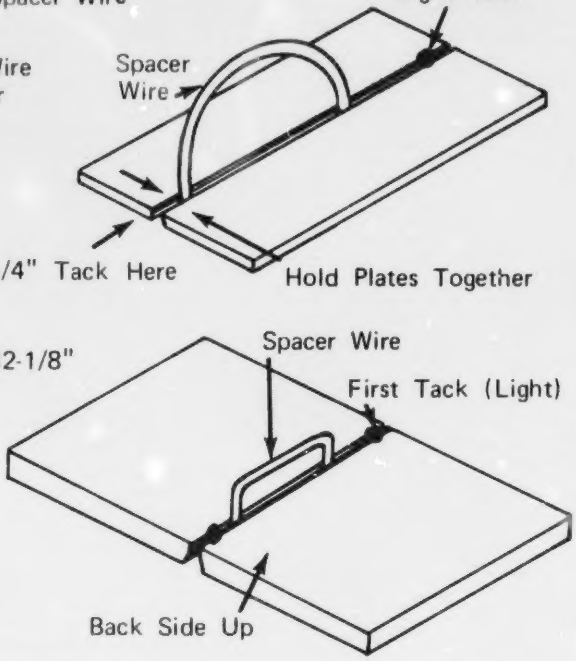

Light Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Spacer Wire
First Tack (Light)
Back Side Up

FIGURE 2

Separate Plates with 3/32-1/8" U-Shaped Wire Spacer

Deposit Light Tack At One End

Joint Spacing Should Be Equal From One End To The Other

4. Slag and feather tacks as necessary

C. Position plates in vertical position (Figure 3)

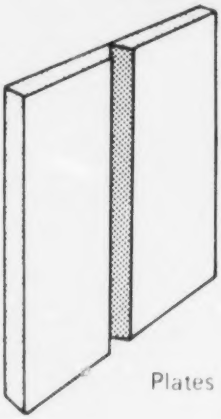


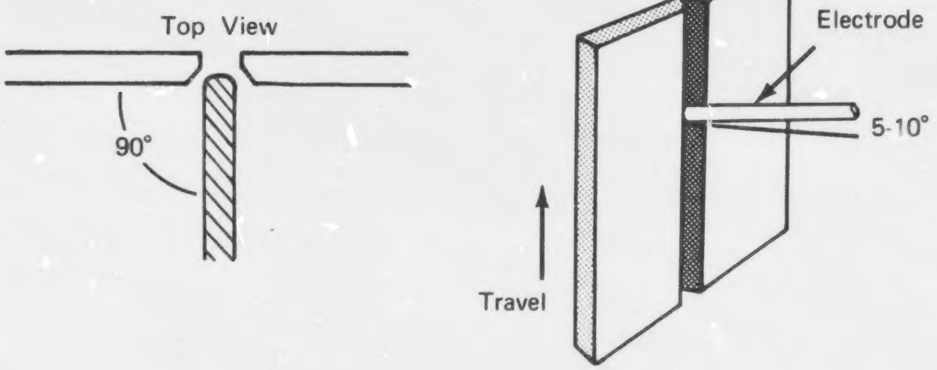
FIGURE 3

Plates Vertical Axis of Weld Vertical

JOB SHEET #13

D. Position electrode 90° or straight into joint angling electrode 5°-10° up from horizontal (Figure 4)

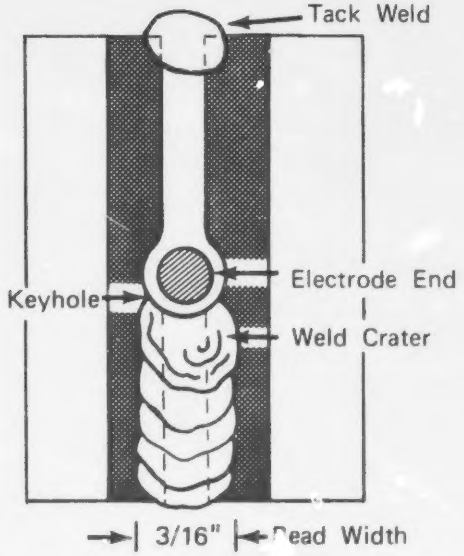
FIGURE 4


Top View
90°
Electrode
5-10°
Travel

E. Strike arc and hold a high arc length to heat plates; move to bottom of plate and start weld

(NOTE: Melt out key hole as large as electrode diameter. See Figure 5.)

FIGURE 5


Tack Weld
Electrode End
Keyhole
Weld Crater
3/16"
Bead Width

JOB SHEET #13

F. Fill crater to about 3/16" bead width

(NOTE: Some form of electrode manipulation is helpful in forming a bead. The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate. See Figure 6.)

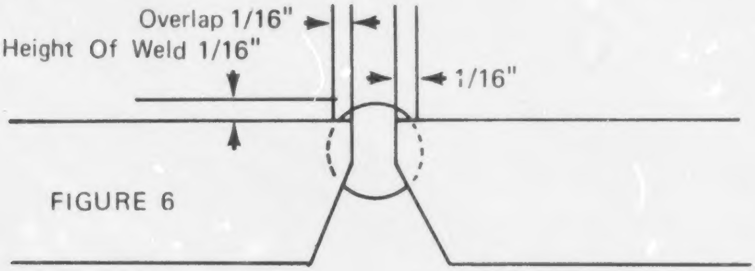
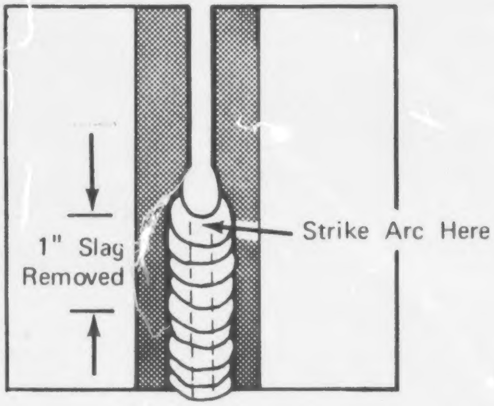


FIGURE 6

G. Remove slag from end of bead and restrike arc below keyhole if arc is broken before completion of bead (Figure 7)

FIGURE 7

Arc-Restriking Procedure



H. Remove slag and brush each weld before applying next pass

I. Deposit necessary filler passes to fill joint using stringers or weaves

J. Make cover pass or passes slightly convex and overlapping top edge of groove 1/16" on each side

K. Cut and prepare coupons

L. Cool plates or coupons in still air slowly

(CAUTION: Do not cool in water.)

M. Test coupons

POSITION WELDING
UNIT I

JOB SHEET #14--MAKE A SINGLE V-GROOVE BUTT JOINT WELD IN THE OVERHEAD POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

  A. Arc welding station with necessary tools and equipment

  B. Mild steel plate, 2 pieces, 3/8" x 5" x 6"

  C. Electrode--E-6010; 1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  D. Current DCRP + at the electrode

  E. Protective clothing

II. Procedure

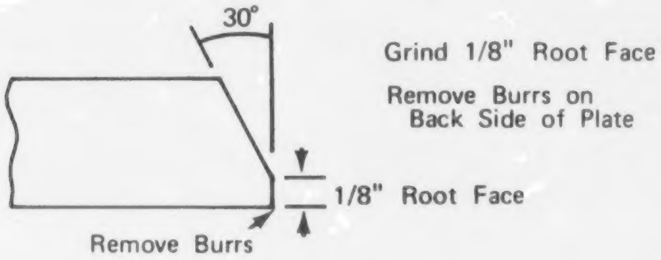
  A. Adjust welding machine for correct current and amperage settings

  B. Prepare plates for welding

    1. Bevel one long side of each plate 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate

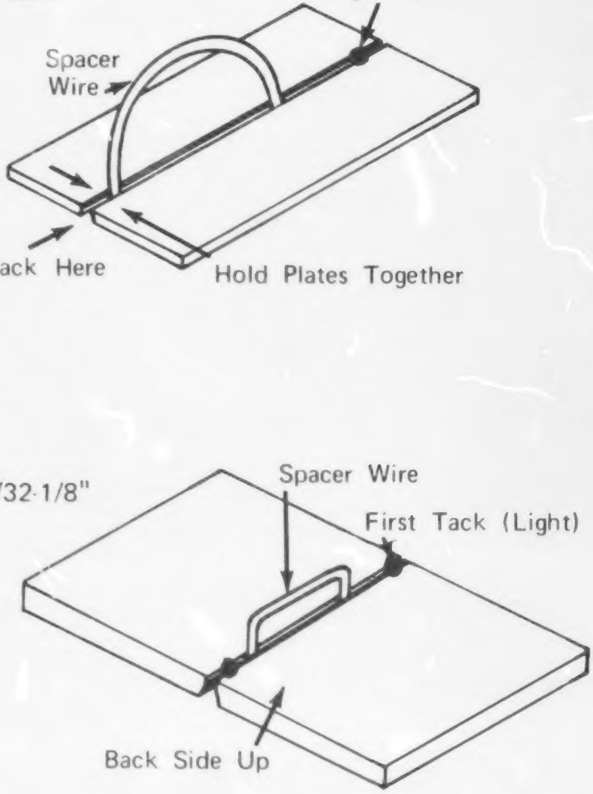

30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

    2. Remove all burrs and slag

JOB SHEET #14

3. Tack plates together with a 3/32"-1/8" root gap (Figure 2)

FIGURE 2



Hold Plates Together Tightly, Separated By One End of Spacer Wire

Remove Spacer Wire Immediately After Depositing Tack

Light Tack
Spacer Wire

Deposit 1/4" Tack Here

Hold Plates Together

Separate Plates with 3/32-1/8" U-Shaped Wire Spacer

Deposit Light Tack At One End

Spacer Wire
First Tack (Light)
Back Side Up

Joint Spacing Should Be Equal From One End To The Other

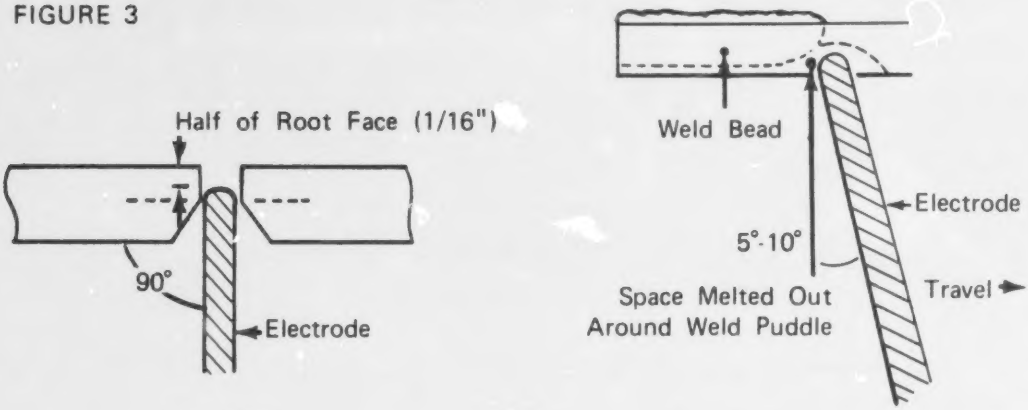
4. Slag and feather tacks if necessary

C. Position plates in overhead position

JOB SHEET #14

D. Hold electrode straight into joint vertically and angled 5°-10° in direction of travel (Figure 3)

FIGURE 3


Half of Root Face (1/16")
90°
Electrode
Weld Bead
Electrode
5°-10°
Space Melted Out
Around Weld Puddle
Travel

End View

Side View

E. Strike arc holding long arc to heat plates and prevent cold lap; move to end of plate and start weld

(NOTE: The root pass should have 100% penetration on both plates extending through root and overlapping 1/16" on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate. See Figure 4.)

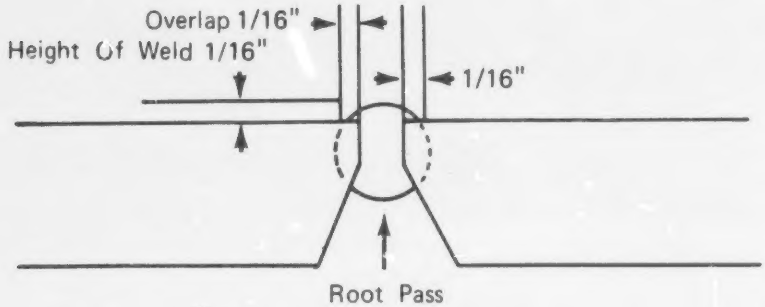

Overlap 1/16"
Height Of Weld 1/16"
1/16"
Root Pass

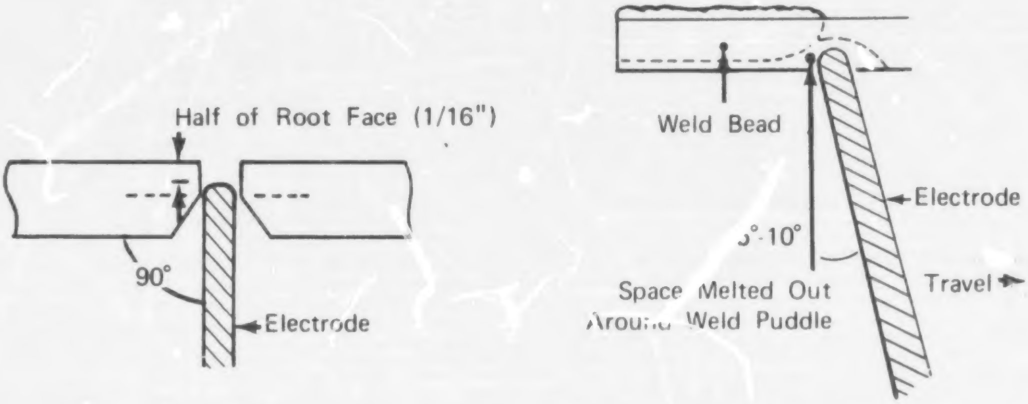
FIGURE 4

JOB SHEET #14

F. Run root pass using the following welding technique

1. Hold short arc length and position end of electrode half-way into root gap (Figure 5)

FIGURE 5

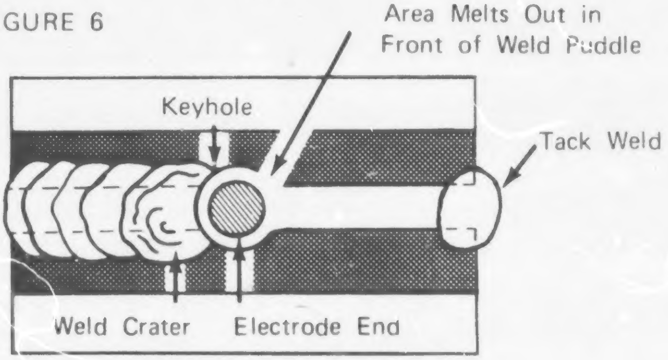

Half of Root Face (1/16")
90°
Electrode
Weld Bead
Electrode
5°-10°
Travel
Space Melted Out Around Weld Puddle

End View

Side View

2. Make sure a keyhole forms in front of weld puddle to insure good fusion to root of joint (Figure C)

FIGURE 6


Area Melts Out in Front of Weld Puddle
Keyhole
Tack Weld
Weld Crater
Electrode End

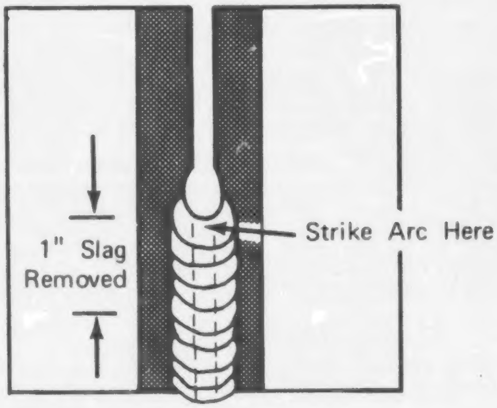
3. Deposit thin layers of filler metal using some form of rod manipulation to control weld puddle

JOB SHEET #14

G. Remove slag from one inch of bead and restrike arc if arc is broken before weld is completed (Figure 7)

FIGURE 7

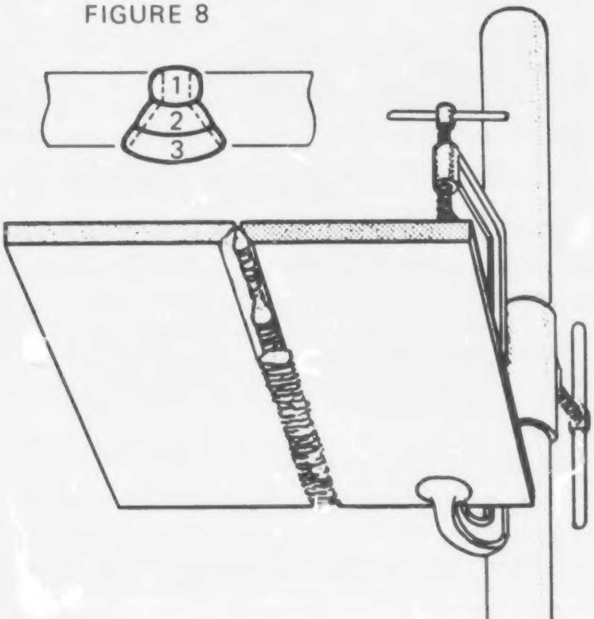
Arc-Restriking Procedure



H. Chip and brush thoroughly after each pass before applying next one

I. Deposit filler passes to fill joint using stringers or weaves (Figure 8)

FIGURE 8



JOB SHEET #14

J. Make sure cover pass or passes are well fused into previous passes with a 1/16" overlap at the top and on both sides of V-joint; bead should be convex in contour

K. Cut and prepare coupons

L. Cool plates in still air, never water

M. Test coupons

POSITION WELDING
UNIT I

TEST

NAME ________________________________ SCORE ____________________

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided. Definitions are continued on the next page.

______a. Series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer

______b. Melting of metals until the molten parts unite with each other

______c. Position of welding wherein welding is performed from the underside of the joint

______d. Gap between the members to be joined at the root of the joint

______e. Running of a horizontal bead on a vertical surface

______f. Deposit of small spots or particles of metal on the base metal alongside the bead

______g. Distance from the original surface of the base metal to that point [illegible]hich fusion ceases

______h. Condition caused by a trapped gas pocket in a weld as it solidifies

______i. Depression in the face of a weld caused by arc force; usually found at the end of a bead

______j. Exposed surface of a fusion weld

______k. Concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path

______l. Nonmetallic porous material entrapped in weld metal or between the weld metal and base metal

1. Penetration
2. Crater
3. Pad
4. Horizontal position
5. Weld face
6. Fusion
7. Spatter
8. Arc blow
9. Overhead position
10. Slag inclusion
11. Root opening
12. Porosity

______m. Portion of the crater left unfilled due to excessive current and the improper movement of the electrode; occurs at the edge of the bead

______n. Beads are deposited vertically on a vertical surface; axis of the weld is vertical

______o. That portion of a weld which is removed from the test plate to test

______p. Weld bead made with very little rod manipulation

______q. Bottom surface of a weld; the opposite side from which the welding was done

______r. Piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld

13. Root
14. Undercutting
15. Vertical position
16. Coupon
17. Cold lap
18. String bead

2. List four factors that determine proper machine adjustment.

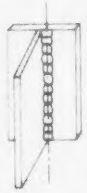
a. ______________________________

b. ______________________________

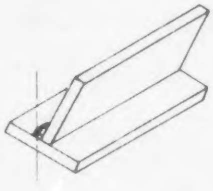
c. ______________________________

d. ______________________________

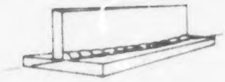
3. Identify the following welding positions by writing the correct names in the blanks.



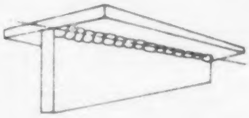
a. ____________________



b. ____________________



c. ____________________



d. ____________________

4. Select from the list below reasons for removing slag from the weld. Place an "X" in the correct blanks.

______a. Permits better fusion of beads

______b. Prevents gas pockets and slag inclusions from forming in bead

______c. Improves appearance of bead

______d. Prevents cold lap or undercutting

5. Describe in a short paragraph the importance of fusing one bead with another.

____

____

____

6. List the factors that determine weld quality.

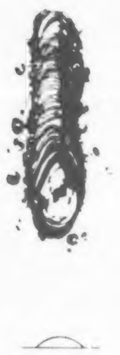
a. ____

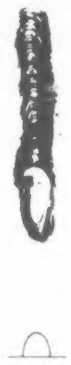
b. ____

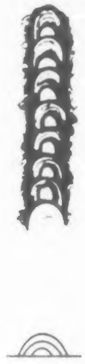
c. ____

d. ____

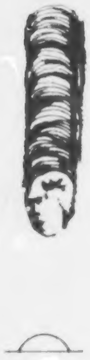
7. Identify the properly and improperly formed beads by telling the causes.



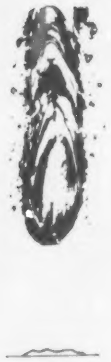




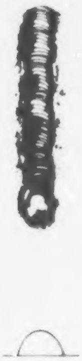
a. ______________ b. ______________ c. ______________



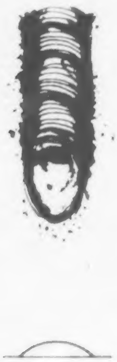
d. ____________________



e. ____________________



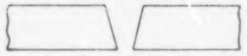
f. ____________________

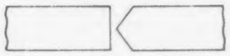


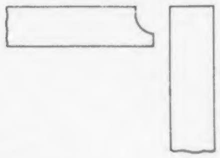
g. ____________________

8. Discuss in a short paragraph the solutions to prevent arc blow.

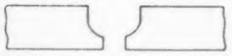
9. Label the following types of groove joints.

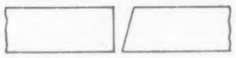


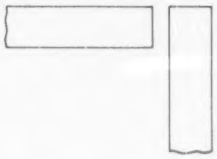




a. ______________ b. ______________ c. ______________

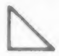


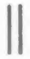


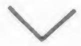


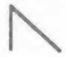
d. ______________ e. ______________ f. ______________

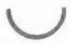
10. Identify the following basic welding symbols used on a drawing.

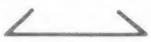
__________a. 

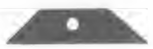
__________b. 

__________c. 

__________d. 

__________e. 

__________f. 

__________g. 

11. Demonstrate the ability to:

a. Make a pad in the horizontal position.

b. Make a multiple pass T-joint fillet weld in the horizontal position.

c. Make a square groove butt joint weld in the horizontal position.

d. Make a pad in the vertical up position.

e. Make a T-joint fillet weld in the vertical up position.

f. Make a square groove butt joint weld in the vertical down position.

g. Make a pad in the overhead position.

h. Make a lap joint fillet weld in the overhead position.

i. Lay out, cut, and prepare test plate.

j. Test the prepared coupon.

k. Make a single V-groove butt joint weld in the flat position and test.

l. Make a single V-groove butt joint weld in horizontal position and test.

m. Make a single V-groove butt joint weld in vertical up position and test.

n. Make a single V-groove butt joint weld in overhead position and test.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

POSITION WELDING
UNIT I

ANSWERS TO TEST

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided. Definitions are continued on the next page.

3 a. Series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer

6 b. Melting of metals until the molten parts unite with each other

9 c. Position of welding wherein welding is performed from the underside of the joint

11 d. Gap between the members to be joined at the root of the joint

4 e. Running of a horizontal bead on a vertical surface

7 f. Deposit of small spots or particles of metal on the base metal alongside the bead

1 g. Distance from the original surface of the base metal to that point at which fusion ceases

12 h. Condition caused by a trapped gas pocket in a weld as it solidifies

2 i. Depression in the face of a weld caused by arc force; usually found at the end of a bead

5 j. Exposed surface of a fusion weld

8 k. Concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path

10 l. Nonmetallic porous material entrapped in weld metal or between the weld metal and base metal

1. Penetration
2. Crater
3. Pad
4. Horizontal position
5. Weld face
6. Fusion
7. Spatter
8. Arc blow
9. Overhead position
10. Slag inclusion
11. Root opening
12. Porosity

14 m. Portion of the crater left unfilled due to excessive current and the improper movement of the electrode; occurs at the edge of the bead

15 n. Beads are deposited vertically on a vertical surface; axis of the weld is vertical

16 o. That portion of a weld which is removed from the test plate to test

18 p. Weld bead made with very little rod manipulation

13 q. Bottom surface of a weld; the opposite side from which the welding was done

17 r. Piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld

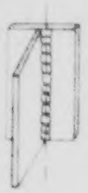
13. Root
14. Undercutting
15. Vertical position
16. Coupon
17. Cold lap
18. String bead

2. List four factors that determine proper machine adjustment.

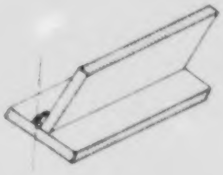
(NOTE: Any four of the following are acceptable.)

a. Length of welding cables
b. Thickness of metal
c. Diameter and type of electrode
d. Welding technique used by operator
e. Efficiency of welding machine
f. Polarity of machine
g. Welding position

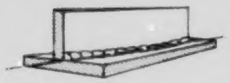
3. Identify the following welding positions by writing the correct names in the blanks.



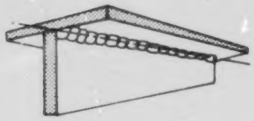
a. Vertical



b. Flat



c. Horizontal



d. Overhead

4. Select from the list below reasons for removing slag from the weld. Place an "X" in the correct blanks.

__X__ a. Permits better fusion of beads

__X__ b. Prevents gas pockets and slag inclusions from forming in bead

__X__ c. Improves appearance of bead

_____ d. Prevents cold lap or undercutting

5. Describe in a short paragraph the importance of fusing one bead with another.

a. Increases strength of weld

b. Improves appearance of weld

c. Improves penetration

6. List the factors that determine weld quality.

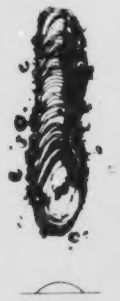
a. Amperage

b. Length of arc

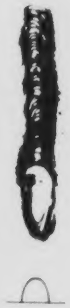
c. Speed of travel

d. Position of electrode

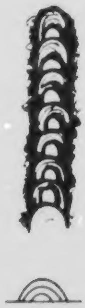
7. Identify the properly and improperly formed beads by telling the causes.



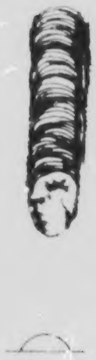
a. Current too high



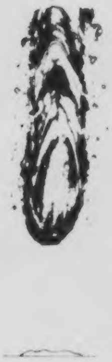
b. Current too low



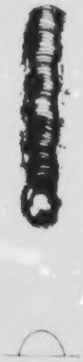
c. Speed too fast



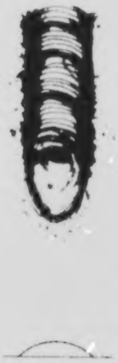
d. Current, voltage, and speed normal



e. Voltage too high



f. Voltage too low



g. Speed too slow

8. Discuss in a short paragraph the solutions to prevent arc blow.

   a. Reduce current

   b. Switch polarity

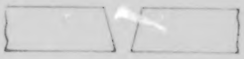
   c. Change current to AC

   d. Change location of ground clamp

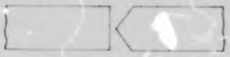
   e. Maintain a short arc

   f. Wrap ground cable around workpiece and pass ground current through it to neutralize magnetic field

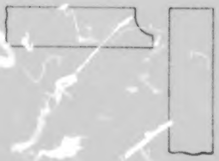
9. Label the following types of groove joints.



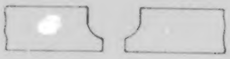
a. Single V



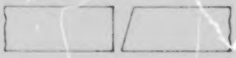
b. Double bevel



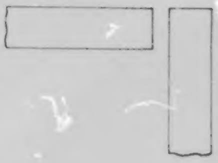
c. J



d. U

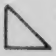


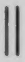
e. Single bevel

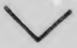


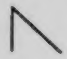
f. Square

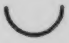
10. Identify the following basic welding symbols.

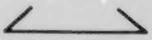
a. Fillet 

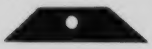
b. Butt or square groove 

c. V 

d. Bevel 

e. U 

f. Plug or slot 

g. Arc seam, arc spot 

11. Demonstrate the ability to:

a. Make a pad in the horizontal position.

b. Make a multiple pass T-joint fillet weld in the horizontal position.

c. Make a square groove butt joint weld in the horizontal position.

d. Make a pad in the vertical up position.

e. Make a T-joint fillet weld in the vertical up position.

f. Make a square groove butt joint weld in the vertical down position.

g. Make a pad in the overhead position.

h. Make a lap joint fillet weld in the overhead position.

i. Lay out, cut, and prepare test plate.

j. Test the prepared coupon.

k. Make a single V-groove butt joint weld in the flat position and test.

l. Make a single V-groove butt joint weld in horizontal position and test.

m. Make a single V-groove butt joint weld in vertical up position and test.

n. Make a single V-groove butt joint weld in overhead position and test.

(NOTE: The performance skills should be evaluated to the satisfaction of the instructor.)

GAS METAL ARC WELDING
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the advantages of the GMAW process and set up and shut down the GMAW equipment for the three major applications of the process. The student should be able to identify the major parts of the GMAW process and common welding mistakes. The student should be able to construct the welds outlined in this unit. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the GMAW process to the correct definitions.
2. List advantages of the GMAW process.
3. Identify the major parts of GMAW equipment.
4. Describe the most common application of the GMAW process.
5. List factors to consider when selecting filler wire for the GMAW process.
6. Name the most common type of GMAW mild steel welding wire.
7. Match the shielding gases to their uses.
8. Identify common welding mistakes.
9. List the characteristics of a good weld.
10. Name the types of power sources for GMAW.
11. Describe the effects of electrode wire stick-out on volts and amps.
12. Demonstrate the ability to:
    a. Set up and shut down GMAW equipment.
    b. Construct a multiple pass T-joint fillet weld in the horizontal position with short arc.
    c. Construct a square groove butt joint in the flat position with short arc.

d. Construct a square groove butt joint in the horizontal position with short arc.

e. Construct a square groove butt weld in the vertical up position with short arc.

f. Construct a square groove butt weld in the overhead position with short arc.

g. Construct a T-joint fillet weld on mild steel in the horizontal position with short arc.

GAS METAL ARC WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Unit references:

   A. *American Welding Society Specifications on GMAW Wire Number A 5.18 and A 5.20.* American Welding Society, 2501 N. 7th Street, Miami, Florida.

   B. Ahella, F. J., and Sullivan, R. P. *Gas Metal-Arc Welding of Stainless Steel Using Short-Circuiting Transfer.* Newark, New Jersey: Linde Division, Union Carbide Corp.

   C. *Hobart Welding School Workbook.* Troy, Ohio: Hobart School of Welding Technology.

   D. *How To Do Manual Metal Inert Gas Welding.* Newark, New Jersey: Linde Division, Union Carbide Corp.

   E. Jefferson, T. B., and Woods, Gorham. 2nd ed. *Metals and How to Weld Them.* Cleveland, Ohio: James F. Lincoln Arc Welding Foundation, 1954.

   F. *The Welding Encyclopedia.* Morton Grove, Illinois: Welding Engineer Publishing Company, Monticello Books.

   G. *Stainless Steel: What It Is and How To Weld It.* Whittier, California: Stoody Company.

   H. *Welding Alcoa Aluminum.* Pittsburgh, Pennsylvania: Aluminum Company of America.

   I. *MIG Welding Aluminum.* Richmond, Virginia: Reynolds Aluminum Company.

J. *Welding Handbook.* 6th ed. Miami, Florida: American Welding Society.

K. Birdsall, G. W., ed. *Fusion Welding Aluminum.* Richmond, Virginia: Reynolds Aluminum Company, 1965.

L. *Micro-Wire Welding.* Troy, Ohio: Hobart Brothers Technical Center.

M. *Hobart Welding Guide and Welding Lessons.* Troy, Ohio: Hobart Welding School.

N. *Fabco Welding.* Troy, Ohio: Hobart Brothers Technical Center.

GAS METAL ARC WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Gas metal arc welding (GMAW)--Arc welding process in which a consumable base electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere (Transparencies 1 and 2)

(NOTE: Gas metal arc welding is sometimes called MIG welding.)

B. Short circuiting transfer (short arc)--Welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions

C. Welding current (amperage)--Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

D. Welding voltage (arc length)--Heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

E. Stick-out--Distance from the contact tip of the gun to the end of the electrode

F. Whiskers--Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

G. Open circuit voltage--Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

H. Arc voltage--Voltage indicated by a volt meter on GMAW power supply when machine is welding

I. Ferrous--Any metal containing iron, such as mild steel or stainless steel

J. Nonferrous--Any metal that contains no iron, such as aluminum or magnesium

K. Shielding gases--Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

INFORMATION SHEET

II. Advantages of the GMAW process

  A. Arc always visible to the welder

  B. No slag and a minimum amount of spatter

  C. High disposition rate with 95% of the welding wire deposited in the joint

  D. Weld metal deposit of low hydrogen quality

  E. Wide range of metal thicknesses can be welded without changing wires

  F. Excellent for bridging gaps or misaligned joints without burn-through

  G. Greatly reduced distortion in gauge metal

  H. Adaptable to weld most any metal by the selection of correct filler wire and shielding gases

  I. Adaptable to either automatic or semiautomatic

III. Major parts of GMAW equipment (Transparency 1)

  A. Power supply

  B. Voltage control

  C. Welding terminals

  D. Power on-off switch

  E. Volt meter

  F. Amp meter

  G. Wire feed control system

  H. Feed rolls

  I. Wire feed control (amperage)

  J. Wire reel or coil

  K. Gun

  L. Shielding gas source (when used)

  M. Flowmeter

  N. Ground

INFORMATION SHEET

IV. Most common application of GMAW process--Short circuiting (short arc), which uses low current, low voltage, and small diameter wires

(NOTE: The short arc process is the most popular of the GMAW processes.)

V. Factors to consider when selecting filler wire for GMAW process

A. Metal to be welded

B. Metal thickness and joint design

C. Metal surface condition

D. Specifications of the job

VI. Most common GMAW mild steel welding wire--Solid

(NOTE: The most popular sizes of solid wire are 0.035" and 0.045".)

VII. Shielding gases and their uses

A. Argon--Used to weld aluminum and magnesium

B. Argon-Helium--Used to weld heavy sections of aluminum

C. Argon-CO_2--Used to weld mild and stainless steel

(NOTE: One of the more popular mixtures for short arc is 75% Argon and 25% CO_2. This mixture is known as C-25.)

D. Helium-Argon-CO_2--Used to weld mild and stainless steel

(NOTE: Another one of the more popular mixes used in short arc welding contains 90% Helium, 7.5% Argon, and 2.5% CO_2.)

E. CO_2--Used for mild steel with short arc and flux cored application

F. Argon-Oxygen--Used for mild, stainless, and alloy steels and copper alloys

(NOTE: The nature of shielding gases requires that GMAW be done where there is no excessive wind or drafts to displace the gas, resulting in brittle, porous welds.)

VIII. Common welding mistakes (Transparency 3)

A. Poor appearance

B. Bad tie-in

INFORMATION SHEET

- C. Whiskers
- D. Insufficient penetration
- E. Suck-back (internal concavity)
- F. Cold lapping
- G. Excessive penetration
- H. Burn-through
- I. Surface porosity

IX. Characteristics of a good weld (Transparency 4)

- A. Well fused throughout joint
- B. Even ripple on bead
- C. Slight crown (convex) at root

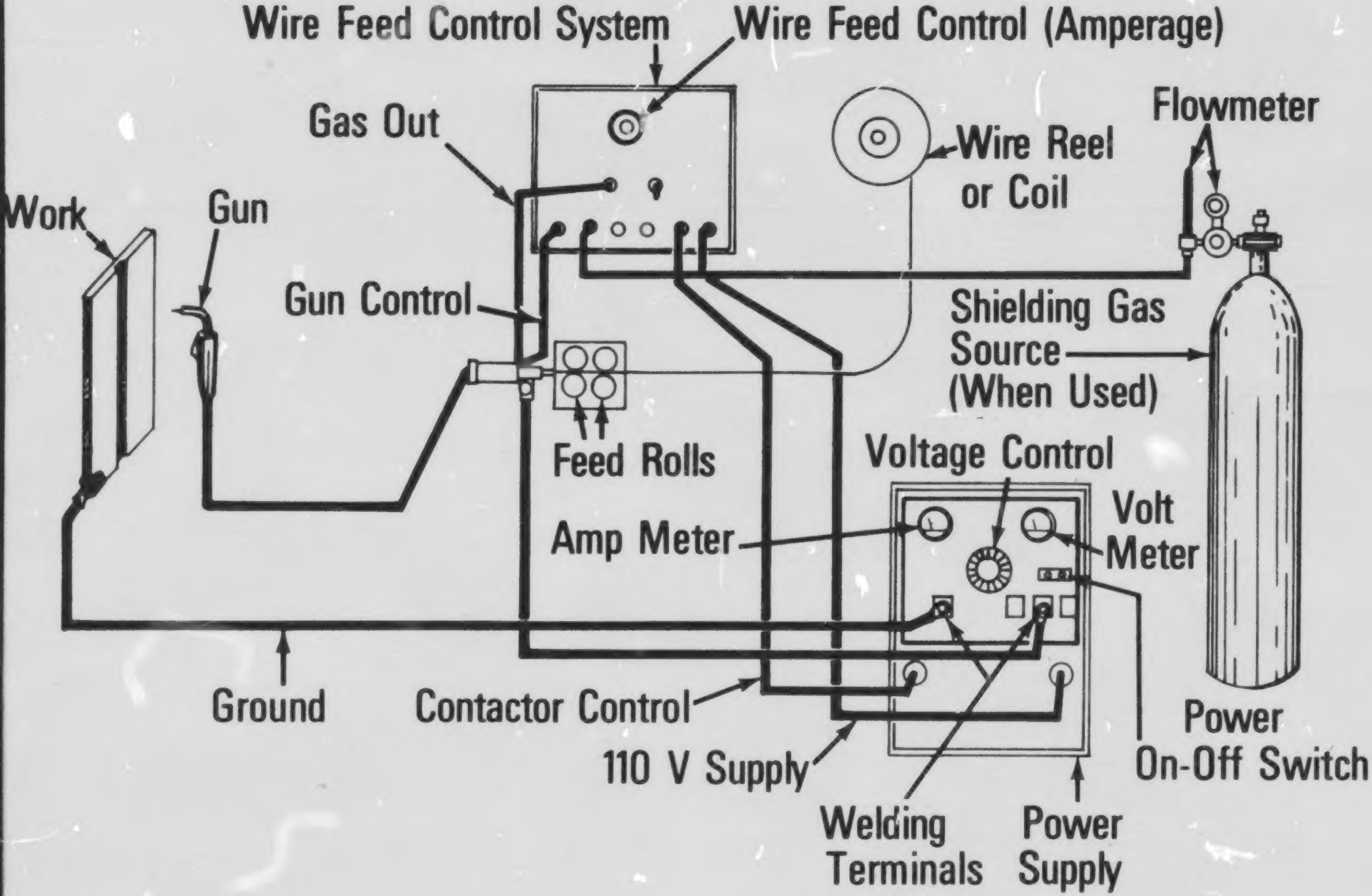
X. Types of power sources

- A. Transformer-rectifier
- B. Engine or motor generator

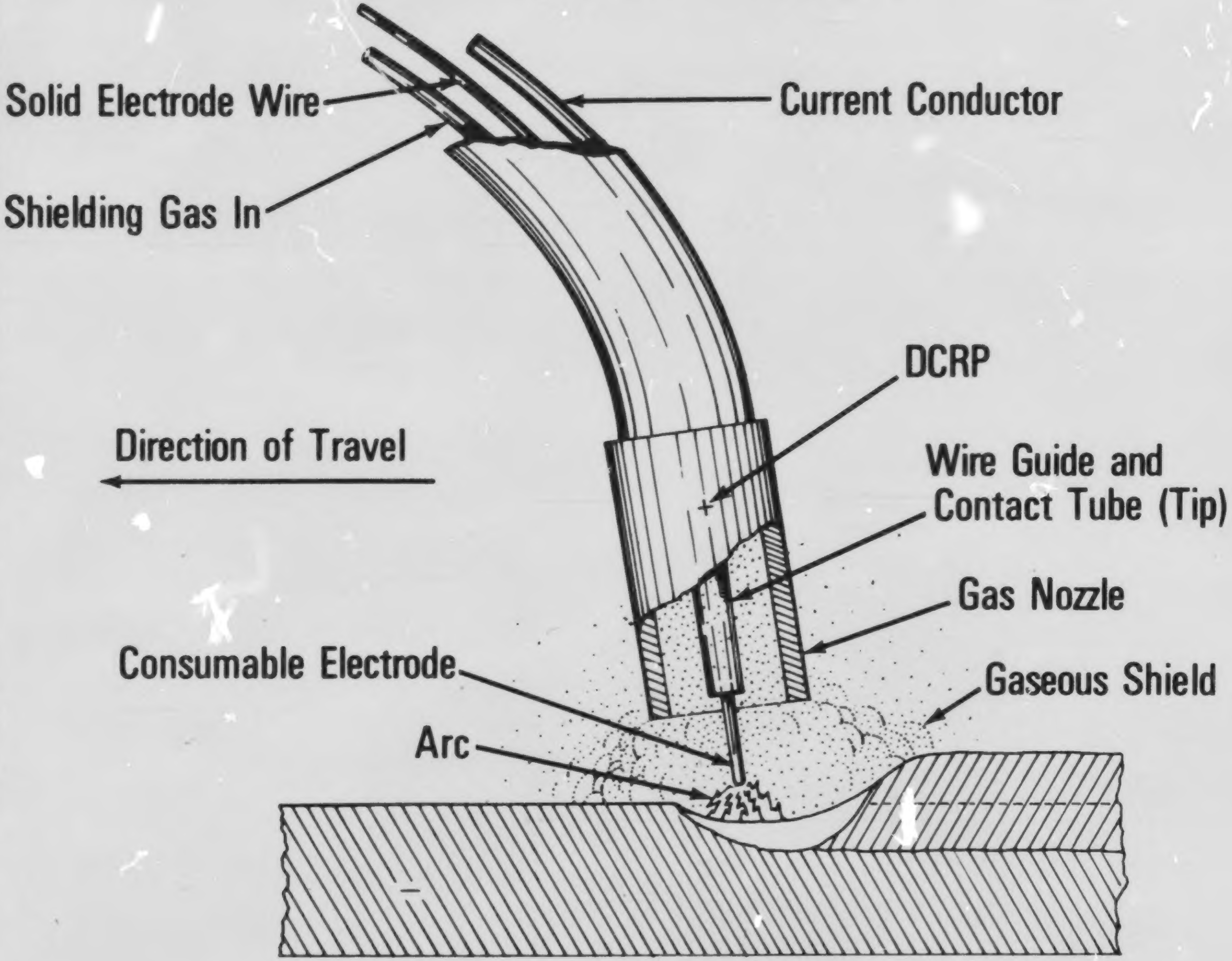
XI. Effects of electrode wire stick-out on volts and amps (Transparencies 5, 6, and 7)

- A. Increased stick-out (long arc)--Increases arc volts and decreases amps
- B. Short stick-out (short arc)--Increases amps and decreases arc volts

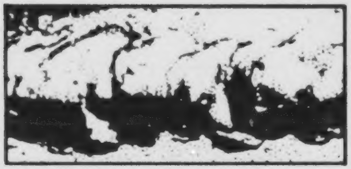
GMAW Equipment


Wire Feed Control System
Wire Feed Control (Amperage)
Gas Out
Wire Reel or Coil
Flowmeter
Work
Gun
Gun Control
Shielding Gas Source (When Used)
Feed Rolls
Voltage Control
Volt Meter
Amp Meter
Ground
Contactor Control
110 V Supply
Power On-Off Switch
Welding Terminals
Power Supply

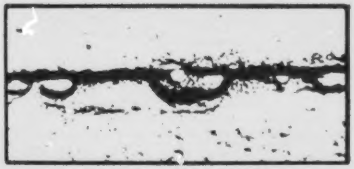
GMAW Process


Solid Electrode Wire
Current Conductor
Shielding Gas In
DCRP
Direction of Travel
Wire Guide and Contact Tube (Tip)
Gas Nozzle
Consumable Electrode
Gaseous Shield
Arc
+
–

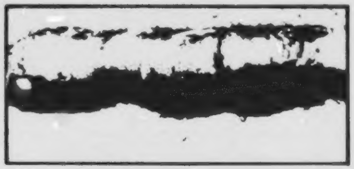
Weld Quality Inspection: Common Welding Mistakes



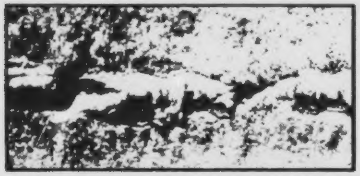
Poor Appearance



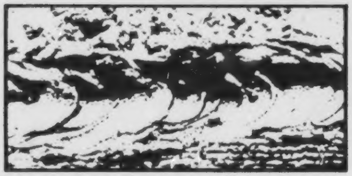
Insufficient Penetration



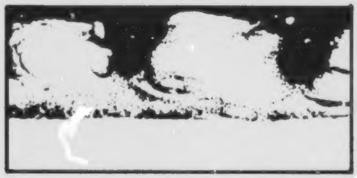
Excessive Penetration



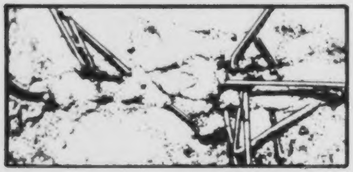
Bad Tie-In



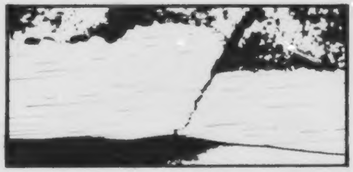
Suck-Back (Internal Concavity)



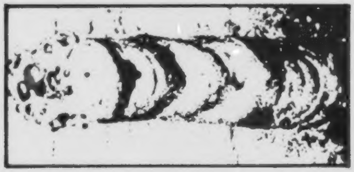
Burn-Through



Whiskers



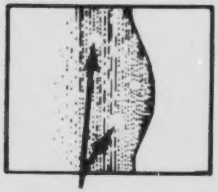
Cold Lapping



Surface Porosity

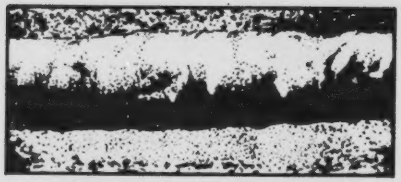
Weld Quality Inspection: Good Welds

End



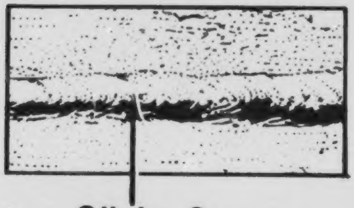
Well-Fused

Top



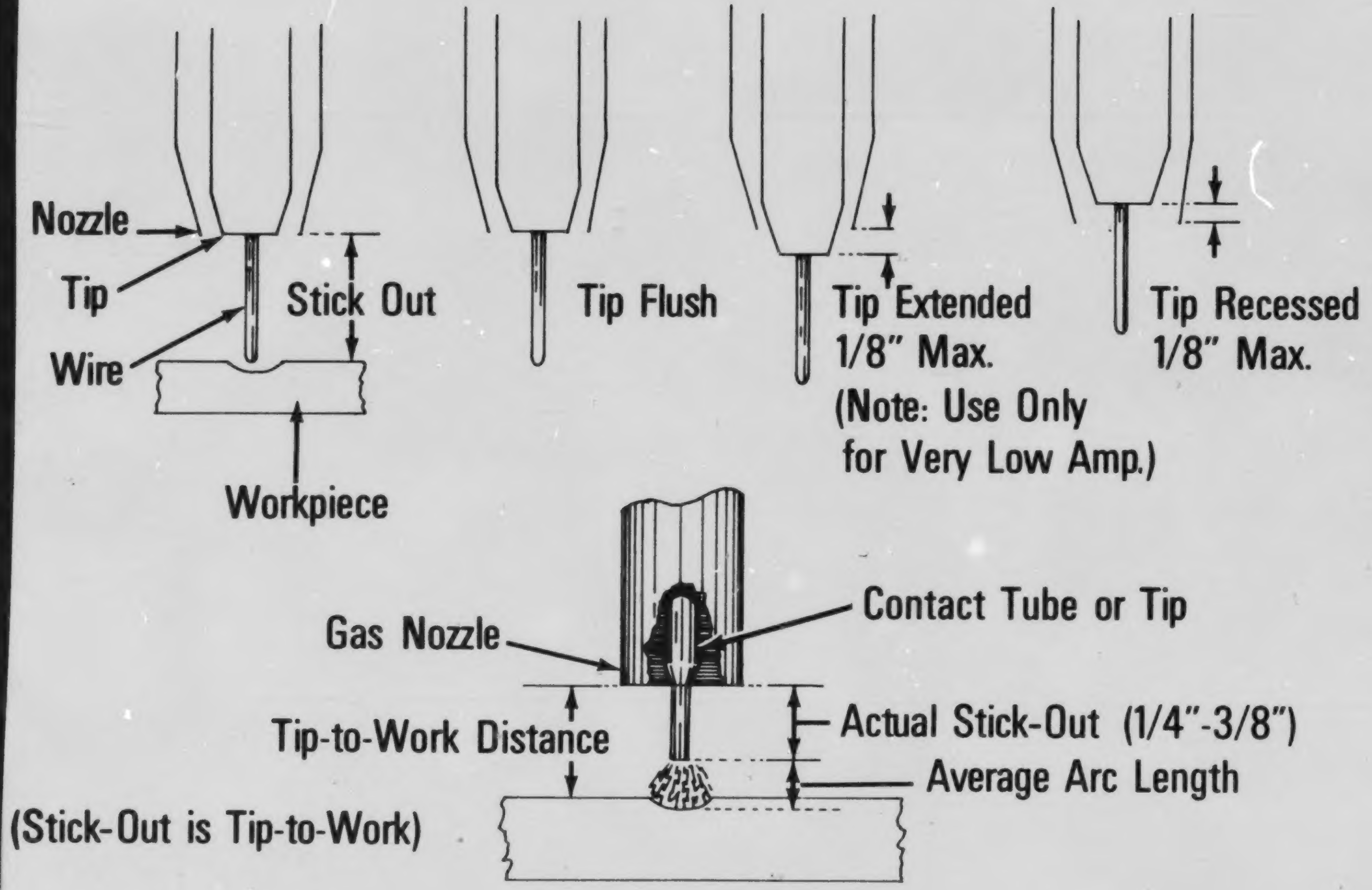
Even Ripple

Bottom

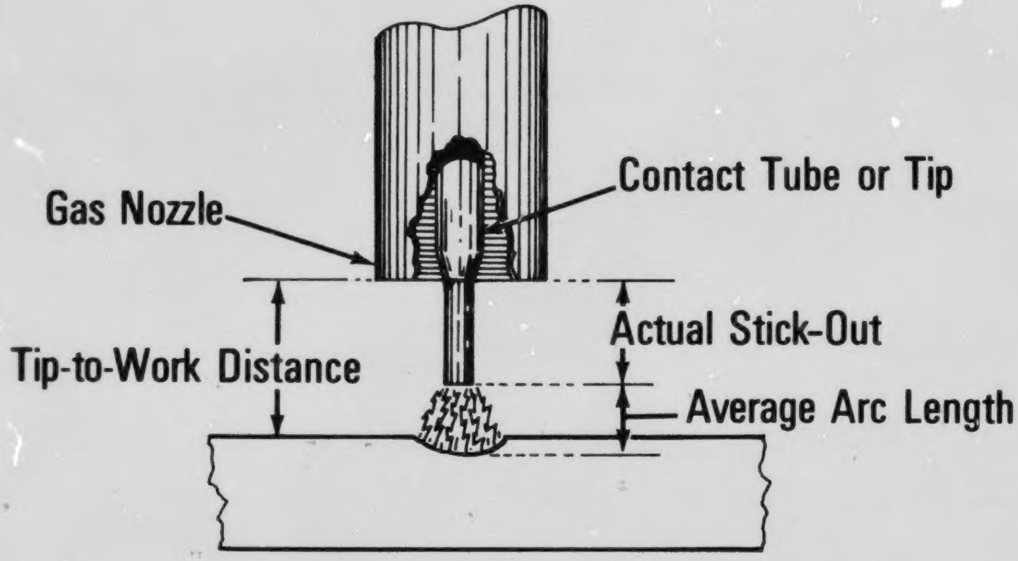


Slight Crown

GMAW Electric Wire Stick-Out


Nozzle
Tip
Wire
Stick Out
Workpiece
Tip Flush
Tip Extended 1/8" Max. (Note: Use Only for Very Low Amp.)
Tip Recessed 1/8" Max.
Contact Tube or Tip
Gas Nozzle
Tip-to-Work Distance
(Stick-Out is Tip-to-Work)
Actual Stick-Out (1/4"-3/8")
Average Arc Length

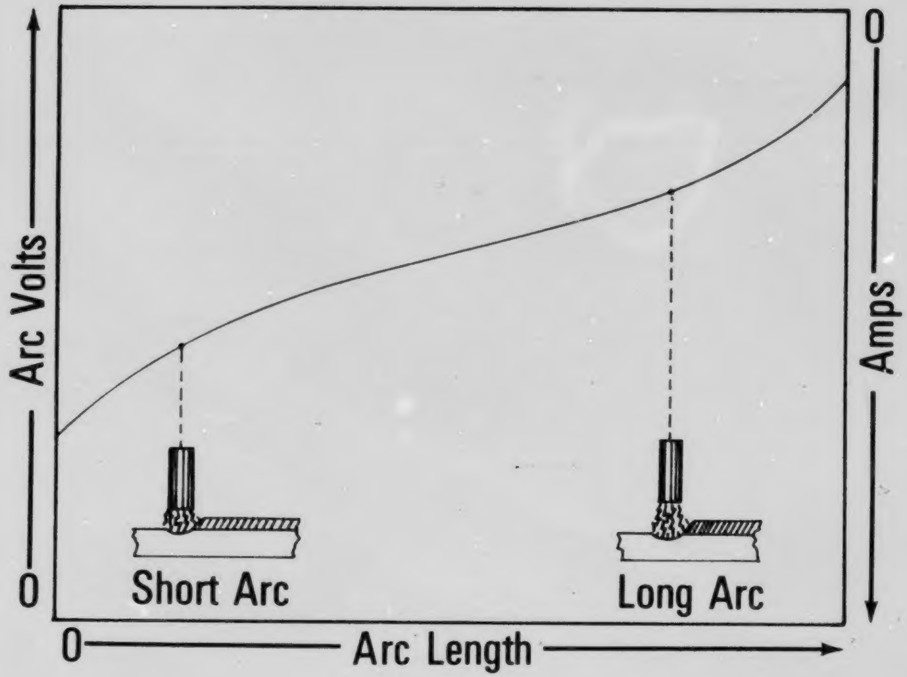
Arc Length and Arc Volt/Amp Characteristics


Contact Tube or Tip
Gas Nozzle
Actual Stick-Out
Tip-to-Work Distance
Average Arc Length

Small Change in Arc Volts (Arc Length Changed by Welder's Movement of Gun) Results in Large Change of Welding Current (Amps)

Arc Length and Arc Volt/Amp Characteristics

(Continued)



Short Arc Length = Increase Amps = Decrease Arc Volts
Long Arc Length = Increase Arc Volts = Decrease Amps

GAS METAL ARC WELDING
UNIT II

JOB SHEET #1--SET UP AND SHUT DOWN GMAW EQUIPMENT

I. Tools and materials

   A. GMAW power supply, feeder wire, and gun (air-cooled)

   B. Shielding gas

      1. For mild steel--CO_2; C-25

      2. For stainless steel--Argon, C-25; Helium-Argon-CO_2; Argon-Oxygen (1-5%)

      3. For aluminum, copper, magnesium--Argon, Helium, or Argon-Helium mixes

   C. Electrode filler wire

      1. Solid--Determined by base metal to be welded

      2. Wire diameters for short arc--0.030", 0.035", 0.045"

   D. Current settings for short arc--DCRP--50-250 amps

   E. Voltage setting for short arc--12-30 arc volts

II. Procedure

   A. Set-up procedure

      1. Set up power supply controls

         a. Start welding machine--Push start switch or start engine if engine-driven

         b. Set machine controls

            1) Voltage

            2) Amperage (if equipped)

      2. Set up wire pad and shielding gas controls

         a. Set up wire feed

            1) Correct size and type of wire

            2) Correct size of feed roll or rolls

JOB SHEET #1

3) Inch wire out to gun using incher control if equipped

4) Adjust tension on feed rolls

(NOTE: Tension should be tight enough to feed wire but should not deform or mark wire.)

5) Turn on power switch

b. Set up and adjust shielding gas controls (if used)

1) Blow out cylinder valve to remove any dirt or foreign material

2) Mount gas flowmeter to cylinder in a vertical position

3) Crack cylinder valve slowly

(NOTE: Check for leaks using soapy water. Ivory soap should be used.)

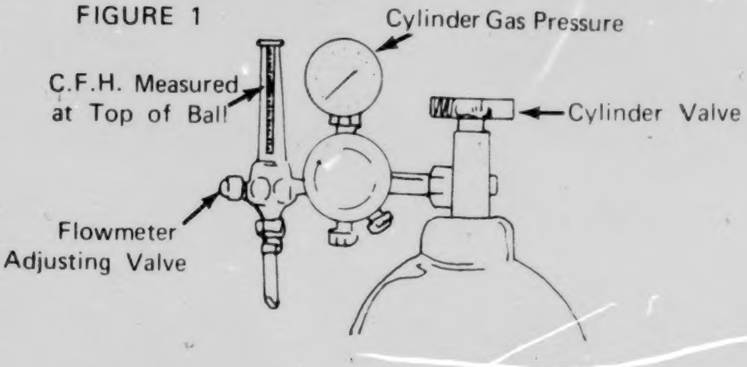
4) Turn wire speed control to zero or release pressure on feed rolls

5) Open flowmeter adjusting valve slowly while depressing gun trigger

(NOTE: This is generally 20-25 lb c.f.h. [cubic feet per hour]. See manufacturer's recommendations.)

6) Adjust desired flow rate (c.f.h.) and release trigger (Figure 1)

FIGURE 1



(NOTE: This is accurate only if gas in cylinder exceeds 50 p.s.i. and is mounted vertically.)

JOB SHEET #1

c. Set wire feed speed (amperage control) to desired setting

(NOTE: Arc voltage and amps should be fine tuned while or after running ahead on scrap metal.)

3. Set up gun

a. Conduit and liners that transport wire to gun should be correct size as well as clean and free of obstructions

(NOTE: Do not use solvents to clean nylon liners used for aluminum.)

b. Contact tip or tube should be correct size for wire being used and free of grease, dirt, or spatter

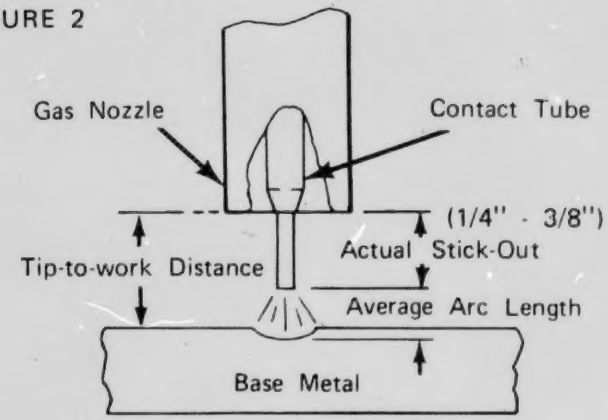
c. Nozzle should be of correct size for welding applications and gas flow volumes and free from spatter

(NOTE: Some form of antispatter compound, either spray can or paste, could be applied to nozzle and contact tip before welding to help prevent spatter build up.)

d. Correct stick-out should be adjusted and maintained for short arc (1/4" - 3/8") (Figure 2)

(NOTE: In this unit, stick-out shall refer to the top-to-work distance.)

FIGURE 2


Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

JOB SHEET #1

B. Shut-down procedure

1. Turn off wire feed speed control
    a. Set control at zero
    b. Move wire feed control switch to Off after bleeding gas lines
2. Shut off shielding gas system (if used)
    a. Close cylinder valve
    b. Depress welding gun trigger until ball in flowmeter zeros
    c. Close flowmeter adjusting valve finger tight
3. Turn off welding power supply
4. Store gun and cable assembly in correct place

GAS METAL ARC WELDING
UNIT II

JOB SHEET #2--CONSTRUCT MULTIPLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Tools and materials

  A. GMAW power supply, wire feeder, and air-cooled gun for short arc application

  B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25% CO_2; 75% Argon)

  C. Electrode filler wire--0.035 diameter A.W.S.#E705-3

  D. Mild steel, 3/16" x 3" x 6", 2 pieces

  E. Personal protective equipment

II. Procedure

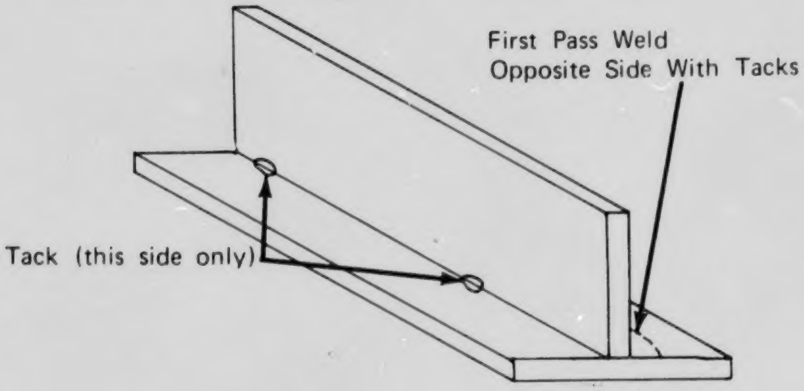
  A. Adjust power supply and wire feeder to correct voltage (19-21 volts) and amperage (140-160 amp)

  B. Adjust wire feed speed to 14-19 IPM (inches per minute)

  C. Set shielding gas flow rate at 20 c.f.h.

  D. Position two plates to form a T-joint and tack (Figure 1)

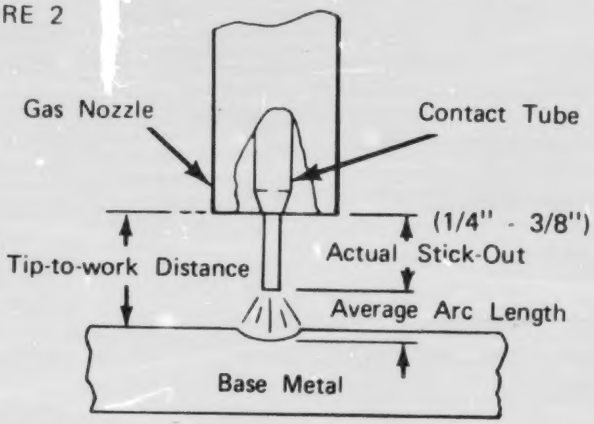
FIGURE 1



JOB SHEET #2

E. Maintain contact stick-out of 1/4"-3/8" (Figure 2)

FIGURE 2

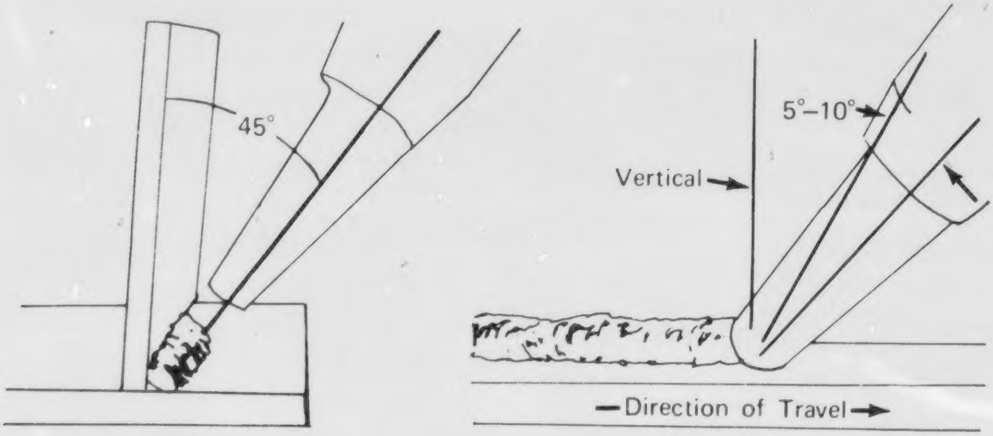

Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

(NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

F. Place metal in flat position

G. Position gun at 45° side angle and 5°-10° in direction of travel for first and second bead (Figure 3)

FIGURE 3


45°
5°–10°
Vertical
—Direction of Travel→

End View

Welder's View

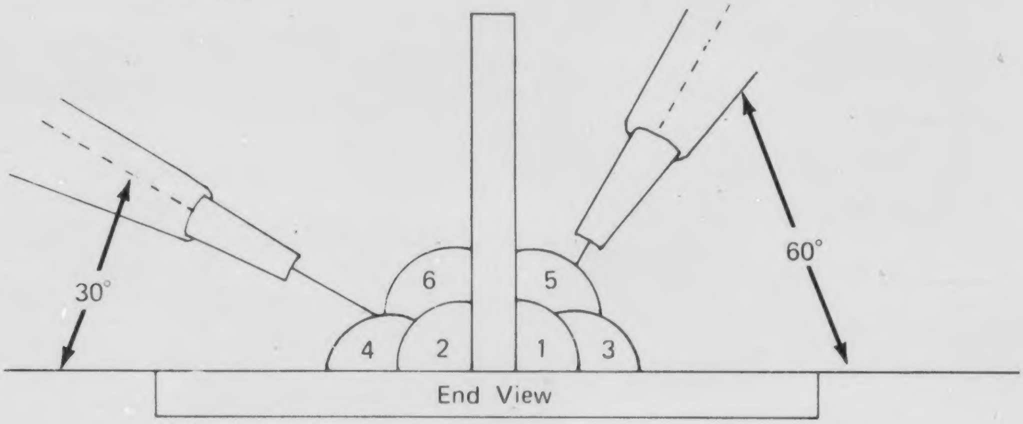
JOB SHEET #2

H. Start arc one inch from starting end of joint, moving quickly to starting end of joint; begin first bead

(NOTE: This technique is used to prevent cold lap, a problem common to GMAW.)

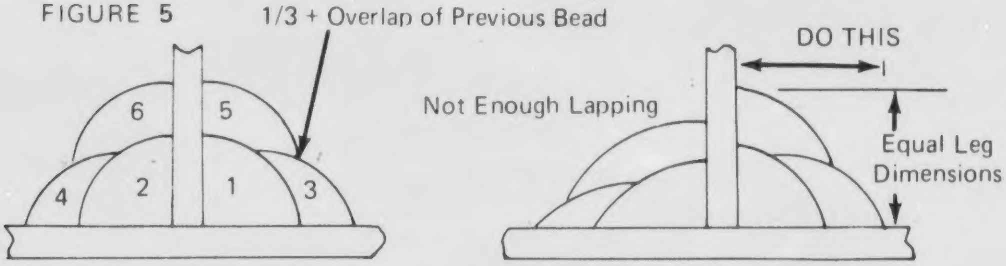
I. Position gun at 30° angle to bottom plate for third and fourth beads and 60° angle to bottom for fifth and sixth beads (Figure 4)

FIGURE 4


30°
60°
6
5
4
2
1
3
End View

. Overlap all beads one-third (Figure 5)

FIGURE 5


1/3 + Overlap of Previous Bead
6
5
4
2
1
3
DO THIS
Not Enough Lapping
Equal Leg Dimensions

Bead Sequence

AVOID THIS

(NOTE: Remember to alternate beads to prevent distortion as shown in Figure 5.)

K. Complete required number of passes

(NOTE: Turn in for instructor's approval.)

GAS METAL ARC WELDING
UNIT II

JOB SHEET #3--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE FLAT POSITION WITH SHORT ARC

I. Tools and materials

A. GMAW power supply, wire feeder, and air-cooled gun for short arc application

B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25% CO_2; 75% Argon)

C. Electrode filler wire--0.035 diameter A.W.S.#E705-3

D. Mild steel, 3/16" x 3" x 6", 2 pieces

E. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage (16-19 volts) and amperage (110-120 amp)

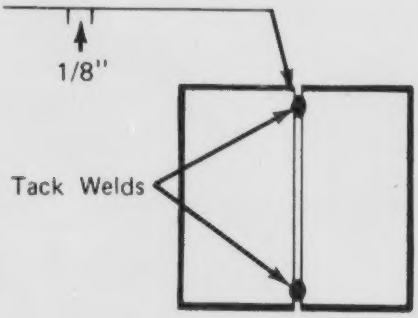
B. Adjust wire feed speed to 14-19 IPM (inches per minute)

C. Set shielding gas flow rate at 20 c.f.h.

D. Position material to form a butt joint with 1/8" root gap and tack (Figure 1)

(NOTE: Be sure that joint is aligned before tacking and that root gap spacing is slightly wider than 1/8" to allow for shrinking of tack. One-eighth inch mild steel filler rod can be used to gap the joint.)

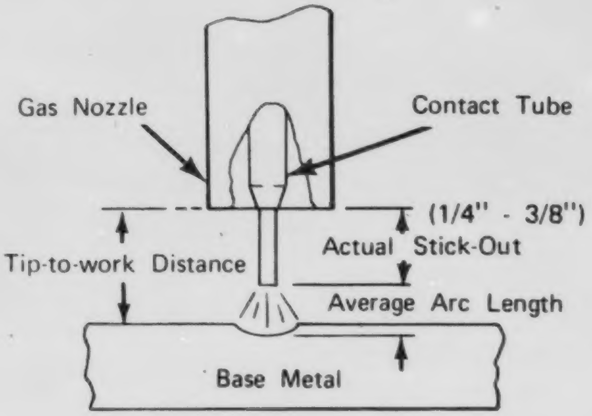
FIGURE 1



JOB SHEET #3

E. Adjust and maintain a stick-out of 1/4"-3/8" during welding procedure (Figure 2)

FIGURE 2


Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

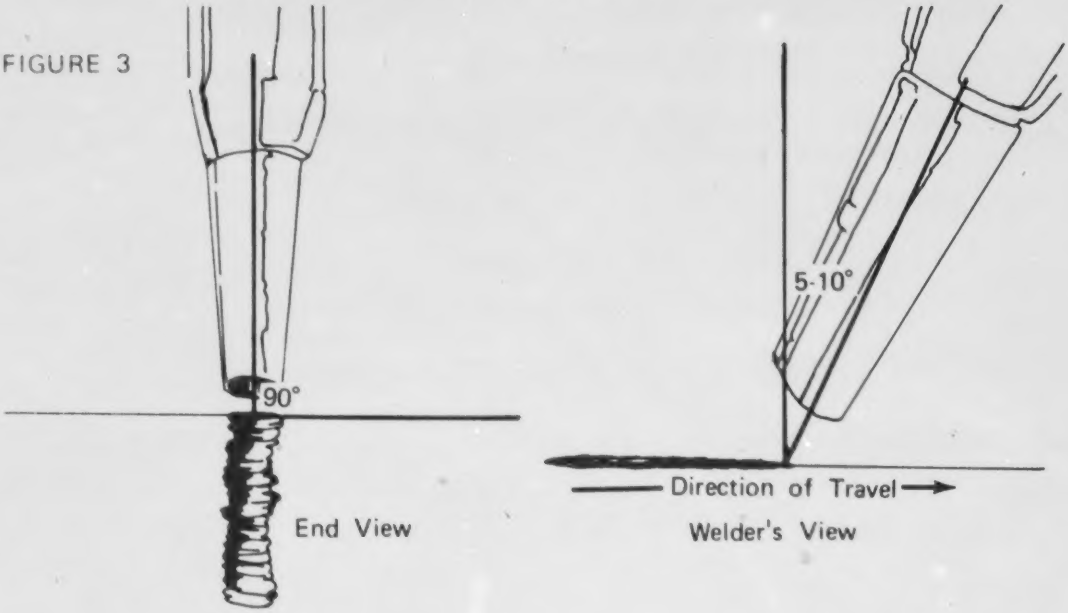
(NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

F. Place metal in flat position

(NOTE: Space metal off table to avoid welding to table through root of joint.)

G. Hold gun in vertical position and 5°-10° in direction of travel (Figure 3)

FIGURE 3


90°
5-10°
Direction of Travel

End View

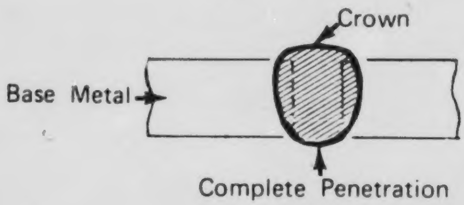
Welder's View

JOB SHEET #3

H. Start arc one inch from end of joint; then move to end of joint and begin welding, keeping the following points in mind

1. Travel at a speed to penetrate the joint completely (Figure 4)

FIGURE 4

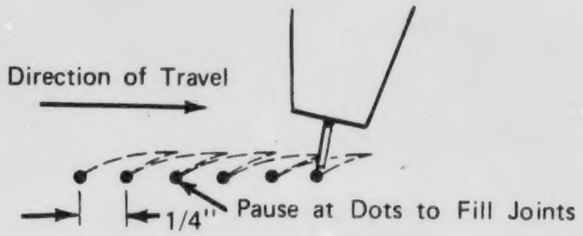

Crown
Base Metal
Complete Penetration

2. Be sure bead crown is higher than surface of base metal

3. Feed electrode wire into leading edge of puddle, being careful to avoid pushing wire through root of joint and out back of plates making whiskers

4. Control weld puddle with a whip and pause motion of electrode (Figure 5)

FIGURE 5


Direction of Travel
1/4"
Pause at Dots to Fill Joints

5. Avoid excessive lengthening of stick-out when oscillating gun

6. Vary electrode to control weld bead

I. Be sure to fill crater at end of joint

J. Inspect root of weld for correct penetration

(NOTE: Turn in for instructor's approval.)

GAS METAL ARC WELDING
UNIT II

JOB SHEET #4--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Tools and materials

A. GMAW power supply, wire feeder, and air-cooled gun for short arc application

B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25% CO_2; 75% Argon)

C. Electrode filler wire--0.035 diameter A.W.S.#E705-3

D. Mild steel, 3/16" x 3" x 6", 2 pieces

E. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage (16-19 volts) and amperage (110-120 amp)

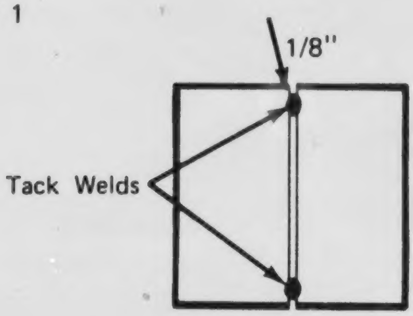
B. Adjust wire feed speed to 14-19 IPM (inches per minute)

C. Set shielding gas flow rate at 20 c.f.h.

D. Position material to form a butt joint with 1/8" root gap; tack weld (Figure 1)

(NOTE: Be sure that joint is aligned before tacking and that root gap spacing is slightly wider than 1/8" to allow for shrinking of tack. One-eighth inch mild steel filler rod can be used to gap the joint.)

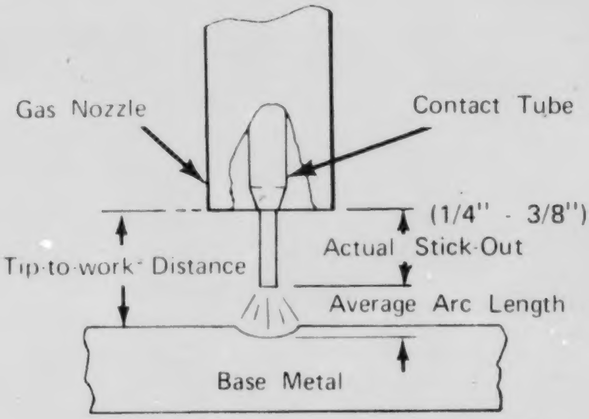
FIGURE 1



JOB SHEET #4

E. Adjust and maintain a stick-out of 1/4"-3/8" during welding procedure (Figure 2)

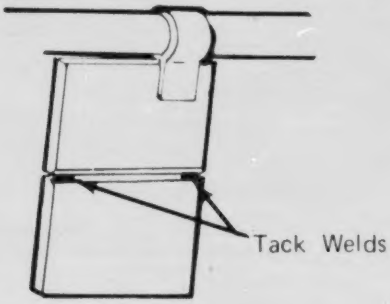
FIGURE 2


Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

(NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

F. Place metal in the horizontal position (Figure 3)

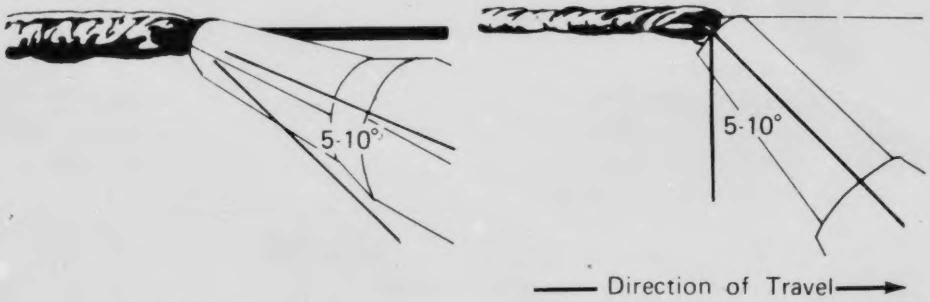
FIGURE 3



JOB SHEET #4

G. Position gun 5°-10° down from horizontal and 5°-10° in direction of travel (Figure 4)

FIGURE 4



Welder's View

Top View

H. Start arc 1/2"-3/4" from end of joint to avoid cold lap; then move to end of joint and begin welding, keeping the following points in mind

1. Travel at speed to penetrate joint completely
2. Manipulate electrode in some form to control puddle
3. Feed electrode filler wire into leading edge of puddle, being careful to avoid getting too close or wire will plunge through to root side of weld causing whiskers to develop

I. Be sure to fill crater at end of joint

J. Inspect weld for complete penetration at the root

(NOTE: Turn in for instructor's approval.)

GAS METAL ARC WELDING
UNIT II

JOB SHEET #5--CONSTRUCT A SQUARE GROOVE BUTT WELD IN THE VERTICAL UP POSITION WITH SHORT ARC

I. Tools and materials

A. GMAW power supply, wire feeder, and air-cooled gun for short arc application

B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25% CO_2; 75% Argon)

C. Electrode filler wire--0.035 diameter A.W.S.#E705-3

D. Mild steel, 3/16" x 3" x 6", 2 pieces

E. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage (16-19 volts) and amperage (110-120 amp)

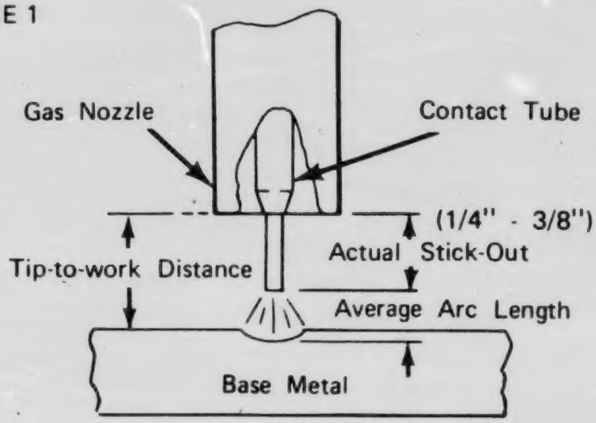
B. Adjust wire feed speed to 14-19 IPM (inches per minute)

C. Set shielding gas flow rate at 20 c.f.h.

D. Adjust stick-out 1/4"-3/8" and clean nozzle if needed (Figure 1)

(NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

FIGURE 1


Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

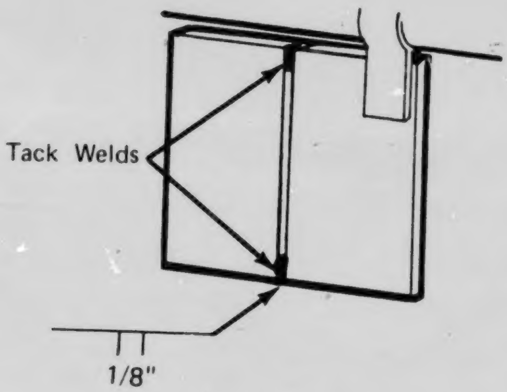
JOB SHEET #5

E. Position material to form a butt joint with 1/8" root gap; tack weld

(NOTE: An 1/8" mild steel filler rod can be used to gap the joint. Be sure root gap spacing is slightly wider than the 1/8" filler rod to allow for shrinking of tack.)

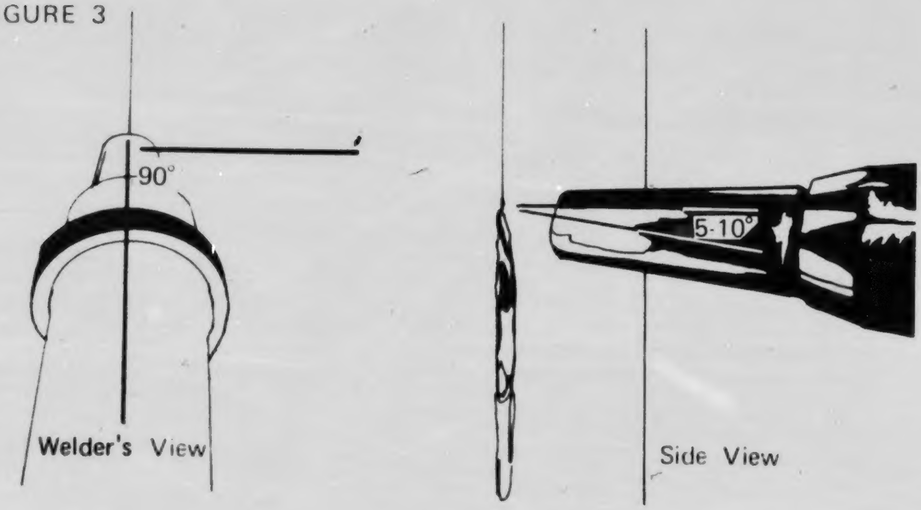
F. Place metal in a vertical position for welding (Figure 2)

FIGURE 2



G. Position gun straight into joint (90°) and angled 5°-10° down from horizontal (Figure 3)

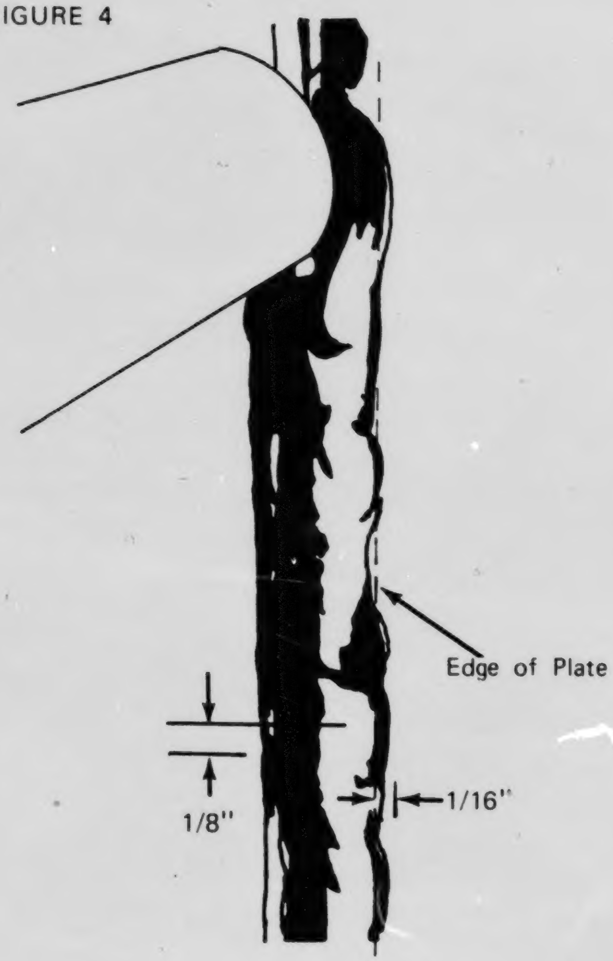
FIGURE 3



JOB SHEET #5

H. Start arc 1/2" to 3/4" up from bottom of joint; then move to bottom end of joint and begin welding, using some type of weaving motion (Figure 4)

FIGURE 4



(NOTE: Care should be taken to keep electrode wire in leading edge of puddle with a stick-out distance of 1/4"-3/8".)

I. Travel at a speed to penetrate joint completely, regulating penetration and bead size by increasing or decreasing travel speed and stick-out

(NOTE: Adjust wire feed as a last resort.)

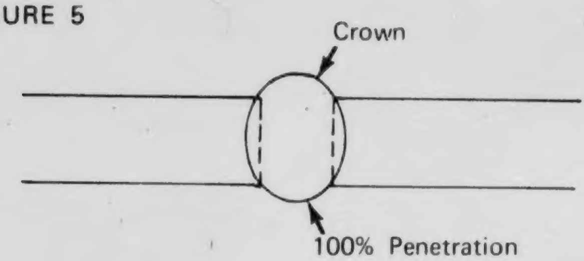
J. Fill crater at end of joint by reversing travel about 1/4" in opposite direction

JOB SHEET #5

K. Inspect weld for complete penetration at the root with a slight crown (Figure 5)

(NOTE: Turn in to instructor for approval.)

FIGURE 5


Crown
100% Penetration

GAS METAL ARC WELDING
UNIT II

JOB SHEET #6--CONSTRUCT A SQUARE GROOVE BUTT WELD IN THE OVERHEAD POSITION WITH SHORT ARC

I. Tools and materials

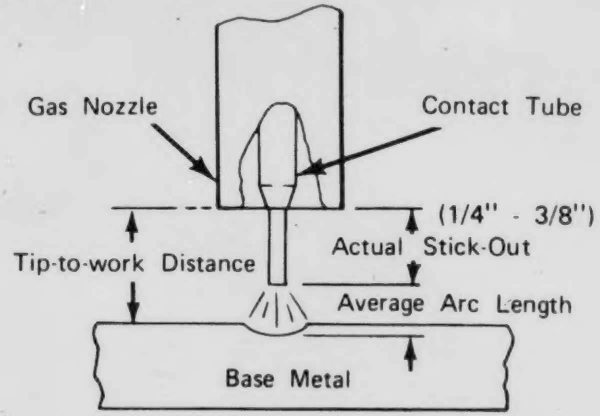
- A. GMAW power supply, wire feeder, and air-cooled gun for short arc application
- B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25% CO_2; 75% Argon)
- C. Electrode filler wire--0.035 diameter A.W.S.#E705-3
- D. Mild steel, 3/16" x 3" x 6", 2 pieces
- E. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage (16-19 volts) and amperage (110-120 amps)
- B. Adjust wire feed speed to 14-19 IPM (inches per minute)
- C. Set shielding gas flow rate at 20 c.f.h.
- D. Adjust stick-out 1/4"-3/8" and clean nozzle if needed (Figure 1)

  (NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

FIGURE 1


Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

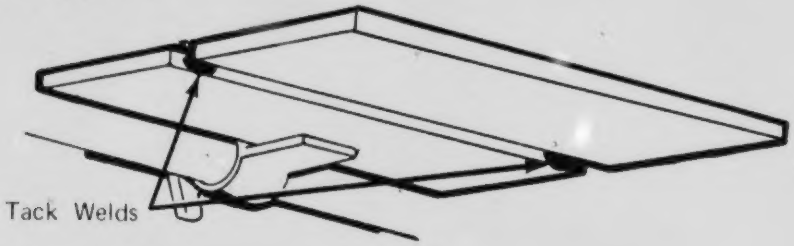
JOB SHEET #6

E. Position material to form a butt joint with 1/8" root gap; tack weld

(NOTE: An 1/8" mild steel filler rod can be used to gap the joint. Be sure root gap spacing is slightly wider than the 1/8" filler rod to allow for shrinking of tack.)

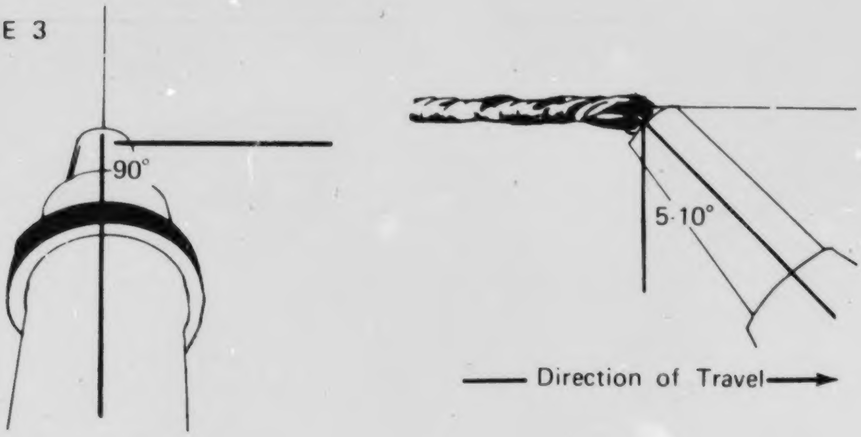
F. Place metal in the overhead position for welding (Figure 2)

FIGURE 2



G. Position gun at a 90° side angle straight up into middle of joint and angled 5°-10° in direction of travel (Figure 3)

FIGURE 3



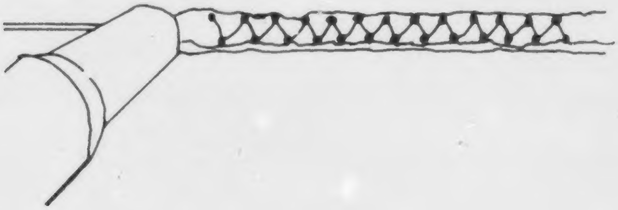
End View

Welder's View

JOB SHEET #6

H. Start arc 3/4" to 1" down the joint; then move to end and begin welding, using some type of weaving manipulation (Figure 4)

FIGURE 4

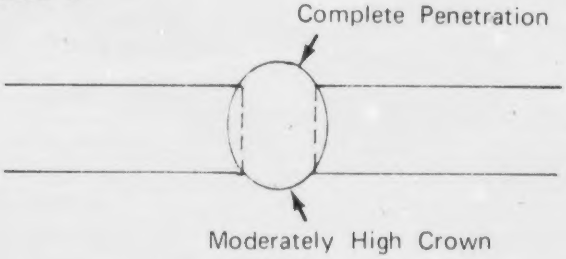


(NOTE: Consult instructor for specific instructions on electrode manipulation.)

I. Travel at a speed that will penetrate joint 100%, regulating penetration and bead size by travel speed, electrode angle, and stick-out (Figure 5)

(NOTE: Adjust wire feed as a last resort. Keep electrode wire in leading edge of puddle with an average stick-out distance of 1/4"-3/8".)

FIGURE 5



J. Fill crater at end of joint by reversing travel 1/4" in opposite direction

K. Inspect weld for complete penetration and correct bead size (Figure 5)

(NOTE: Turn in for instructor's approval.)

GAS METAL ARC WELDING
UNIT II

JOB SHEET #7--CONSTRUCT T-JOINT FILLET WELD ON MILD STEEL IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Tools and materials

A. GMAW power supply, wire feeder, and air-cooled gun for short arc application

B. Shielding gas--CO_2 or C-25 at 15-20 c.f.h. (25% CO_2; 75% Argon)

(NOTE: C-25 is the preferred gas due to less penetration.)

C. Electrode filler wire--0.035 diameter A.W.S. #E705-3

(NOTE: 0.030 wire can be substituted for 0.035.)

D. Mild steel, 16 ga. x 3" x 6", 2 pieces

E. Personal protective equipment

II. Procedure

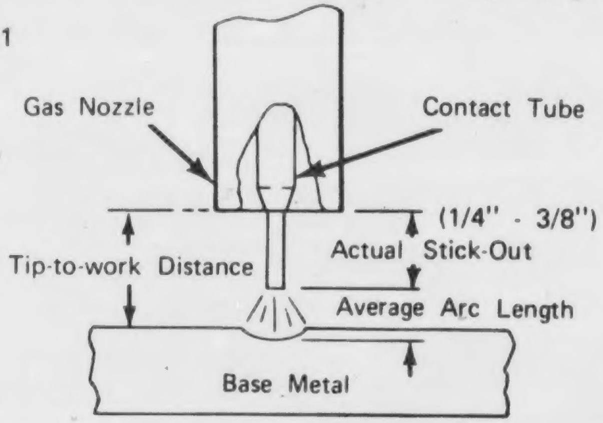
A. Adjust power supply and wire feeder to correct voltage (15-18 volts) and amperage (110-120 amps)

B. Adjust wire feed speed to 14-19 IPM (inches per minute)

C. Set shielding gas flow rate at 15-20 c.f.h.

D. Adjust stick-out 1/4"-3/8" and clean nozzle if needed (Figure 1)

FIGURE 1

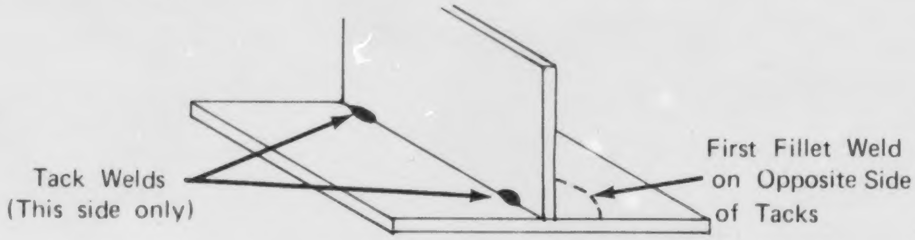

Gas Nozzle
Contact Tube
(1/4" - 3/8")
Actual Stick-Out
Tip-to-work Distance
Average Arc Length
Base Metal

(NOTE: Some type of antispatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #7

E. Position material to form a T-joint; tack weld (Figure 2)

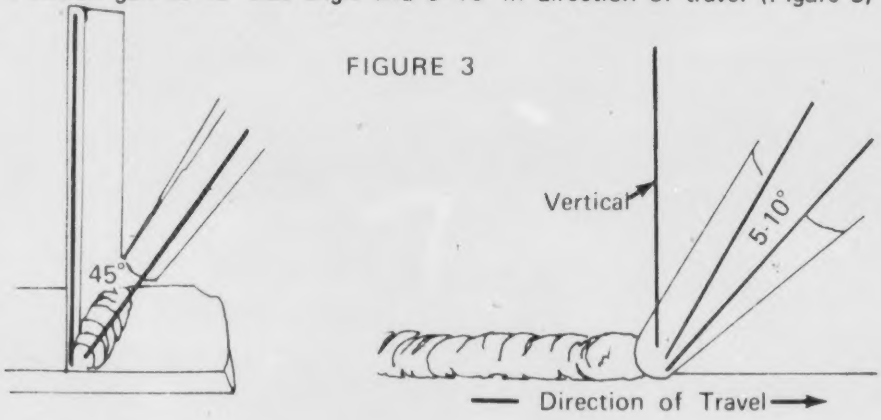
FIGURE 2


Tack Welds
(This side only)
First Fillet Weld
on Opposite Side
of Tacks

F. Position metal flat on table for welding

G. Position gun at 45° side angle and 5°-10° in direction of travel (Figure 3)

FIGURE 3


45°
Vertical
5-10°
Direction of Travel

End View

Welder's View

(NOTE: Normal direction of travel would be from left to right with the backhand technique. The forehand technique can be used on thinner gauge metals where overpenetration is a problem.)

H. Start arc 1/2" to 3/4" from starting end of joint; move electrode back to starting point; begin weld at the end of joint; reverse electrode travel for 1/4"; fill crater

(NOTE: This technique is used to prevent cold lap and crater cracks.)

I. Use faster travel speed on thinner gauge metals, allowing for stick-out

J. Cool metal and weld other side using the same procedure

K. Inspect joint for improper starts, finishes, cold lap, or distortion of the workpiece

(NOTE: Turn in for instructor's approval.)

GAS METAL ARC WELDING
UNIT II

TEST

NAME ______________________________ SCORE ____________________

1. Match terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

______a. Heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

______b. Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

______c. Arc welding process in which a consumable base electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere

______d. Welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions

______e. Voltage indicated by a volt meter on GMAW power supply when machine is welding

______f. Any metal containing iron, such as mild steel or stainless steel

______g. Any metal that contains no iron, such as aluminum or magnesium

______h. Distance from the contact tip of the gun to the end of the electrode

1. Arc voltage
2. Ferrous
3. Nonferrous
4. Stick-out
5. Short circuiting transfer (short arc)
6. Welding voltage (arc length)
7. Welding current (amperage)
8. Gas metal arc welding (GMAW)
9. Open circuit voltage
10. Whiskers
11. Shielding gases

______i. Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

______j. Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

______k. Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

2. List six advantages of the GMAW process.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

d. ______________________________

____

e. ______________________________

____

f. ______________________________

____

3. Identify the major parts of the GMAW equipment by writing the correct names in the blanks provided.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

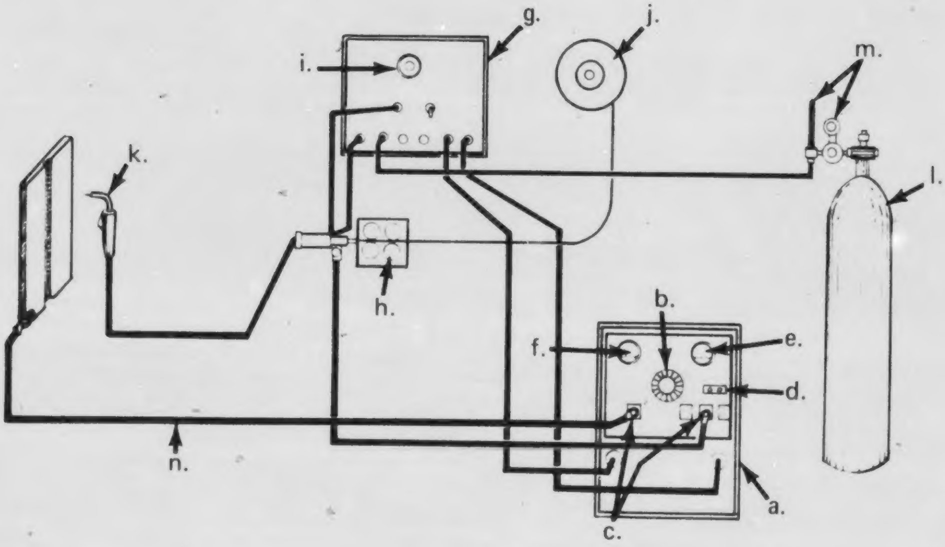
j. ______________________________

k. ______________________________

l. ______________________________

m. ______________________________

n. ______________________________


g.
j.
i.
m.
k.
l.
h.
b.
f.
e.
d.
n.
a.
c.

4. Describe the most common application of the GMAW process.

____

____

____

5. List factors to consider when selecting filler wire for the GMAW process.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

6. Name the most common type of GMAW mild steel welding wire.

____

7. Match the shielding gases on the right to their uses by placing the appropriate numbers in the blanks provided. A blank may have more than one answer.

______a. Used to weld aluminum and magnesium

______b. Used to weld heavy sections of aluminum

______c. Used to weld mild and stainless steel

______d. Used for mild steel with short arc and flux cored application

______e. Used for mild, stainless, and alloy steels and copper alloys

1. Argon-CO_2
2. Argon
3. Argon-Helium
4. Helium-Argon-CO_2
5. CO_2
6. Argon-Oxygen

8. Identify common welding mistakes by matching the name of the mistake to the illustration.

______a. Cold lapping

______b. Excessive penetration

______c. Insufficient penetration

______d. Burn-through

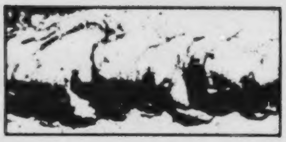
______e. Surface porosity

______f. Poor appearance

______g. Whiskers

______h. Bad tie-in

______i. Suck-back (internal concavity)



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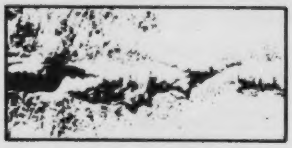

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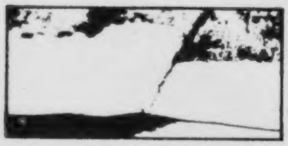

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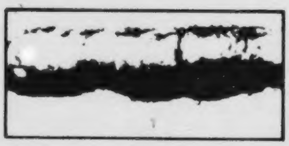

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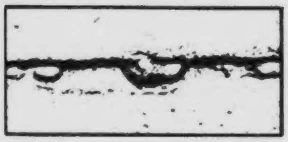

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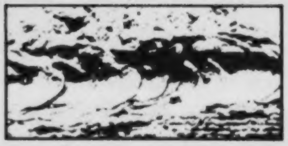

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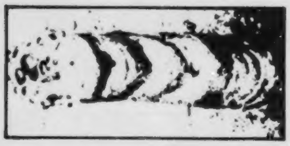

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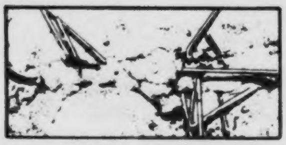


9

9. List the characteristics of a good weld.

a. ______________________________

b. ______________________________

c. ______________________________

10. Name the types of power sources for GMAW.

    a. ____________________

    b. ____________________

11. Describe the effects of electrode wire stick-out on volts and amps.

    a. Increased stick-out (long arc)-- ____________________

    ____

    b. Short stick-out (short arc)-- ____________________

    ____

12. Demonstrate the ability to:

    a. Set up and shut down GMAW equipment.

    b. Construct a multiple pass T-joint fillet weld in the horizontal position with short arc.

    c. Construct a square groove butt joint in the flat position with short arc.

    d. Construct a square groove butt joint in the horizontal position with short arc.

    e. Construct a square groove butt weld in the vertical up position with short arc.

    f. Construct a square groove butt weld in the overhead position with short arc.

    g. Construct a T-joint weld on mild steel in the horizontal position with short arc.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

GAS METAL ARC WELDING
UNIT II

ANSWERS TO TEST

1. Match terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

_6_ a. Heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

_7_ b. Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

_8_ c. Arc welding process in which a consumable base electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere

_5_ d. Welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions

_1_ e. Voltage indicated by a volt meter on GMAW power supply when machine is welding

_2_ f. Any metal containing iron, such as mild steel or stainless steel

_3_ g. Any metal that contains no iron, such as aluminum or magnesium

_4_ h. Distance from the contact tip of the gun to the end of the electrode

1. Arc voltage
2. Ferrous
3. Nonferrous
4. Stick-out
5. Short circuiting transfer (short arc)
6. Welding voltage (arc length)
7. Welding current (amperage)
8. Gas metal arc welding (GMAW)
9. Open circuit voltage
10. Whiskers
11. Shielding gases

_10_ i. Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

_9_ j. Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

_11_ k. Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

2. List six advantages of the GMAW process.

(NOTE: Any six of the following are acceptable.)

a. Arc always visible to the welder

b. No slag and a minimum amount of spatter

c. High disposition rate with 95% of the welding wire deposited in the joint

d. Weld metal deposit of low hydrogen quality

e. Wide range of metal thicknesses can be welded without changing wires

f. Excellent for bridging gaps or misaligned joints without burn-through

g. Greatly reduced distortion in gauge metal

h. Adaptable to weld most any metal by the selection of the correct filler wire and shielding gases

i. Adaptable to either automatic or semiautomatic

3. Identify the major parts of the GMAW equipment by writing the correct names in the blanks provided.

a. Power supply

b. Voltage control

c. Welding terminals

d. Power on-off switch

e. Volt meter

f. Amp meter

g. Wire feed control system

h. Feed rolls

i. Wire feed control (amperage)

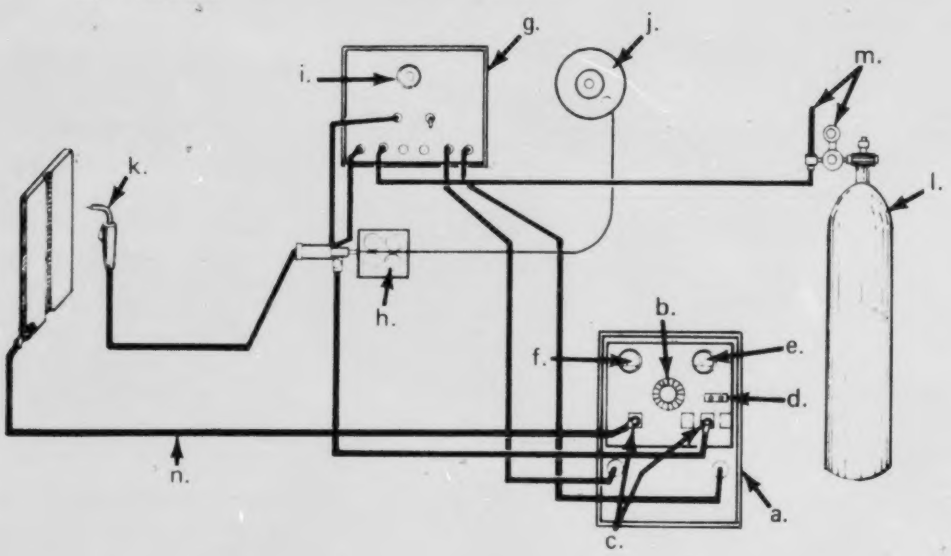
j. Wire reel or coil

k. Gun

l. Shielding gas source (when used)

m. Flowmeter

n. Ground



4. Describe the most common application of the GMAW process.

Short circuiting (short arc), which uses low current, low voltage, and small diameter wires

5. List factors to consider when selecting filler wire for the GMAW process.

a. Metal to be welded

b. Metal thickness and joint design

c. Metal surface condition

d. Specifications of the job

6. Name the most common type of GMAW mild steel welding wire.

Solid

7. Match the shielding gases on the right to their uses by placing the appropriate numbers in the blanks provided. A blank may have more than one answer.

2 a. Used to weld aluminum and magnesium

3 b. Used to weld heavy sections of aluminum

1,4 c. Used to weld mild and stainless steel

5 d. Used for mild steel with short arc and flux cored application

6 e. Used for mild, stainless, and alloy steels and copper alloys

1. Argon-CO_2
2. Argon
3. Argon-Helium
4. Helium-Argon-CO_2
5. CO_2
6. Argon-Oxygen

8. Identify common welding mistakes by matching the name of the mistake to the illustration.

4 a. Cold lapping

5 b. Excessive penetration

6 c. Insufficient penetration

3 d. Burn-through

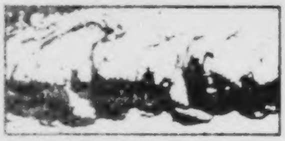
8 e. Surface porosity

1 f. Poor appearance

9 g. Whiskers

2 h. Bad tie-in

7 i. Suck-back (internal concavity)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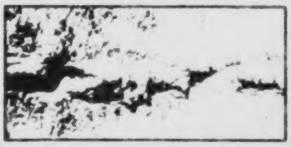
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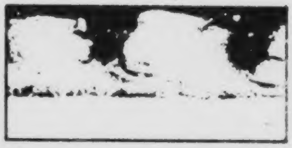
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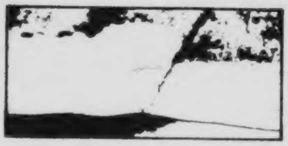

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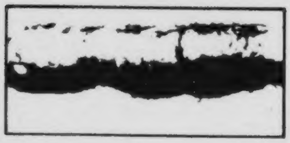

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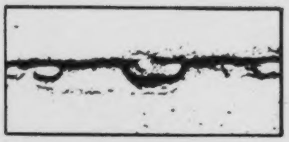

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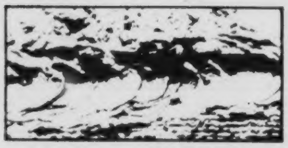

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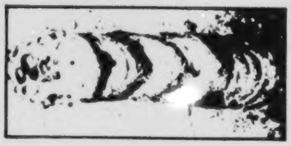

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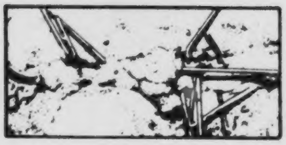

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9. List the characteristics of a good weld.

   a. Well fused throughout joint

   b. Even ripple on bead

   c. Slight crown (convex) at root

10. Name the types of power sources for GMAW.

    a. Transformer-rectifier

    b. Engine or motor generator

11. Describe the effects of electrode wire stick-out on volts and amps.

    a. Increased stick-out (long arc)--Increases arc volts and decreases amps

    b. Short stick-out (short arc)--Increases amps and decreases arc volts

12. Demonstrate the ability to:

    a. Set up and shut down GMAW equipment.

    b. Construct a multiple pass T-joint fillet weld in the horizontal position with short arc.

c. Construct a square groove butt joint in the flat position with short arc.

d. Construct a square groove butt joint in the horizontal position with short arc.

e. Construct a square groove butt weld in the vertical up position with short arc.

f. Construct a square groove butt weld in the overhead position with short arc.

g. Construct a T-joint weld on mild steel in the horizontal position with short arc.

(NOTE: The performance skills should be evaluated to the satisfaction of the instructor.)

OXYACETYLENE CUTTING
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to properly light, adjust, and turn off oxyacetylene cutting equipment following the proper order and safety precautions. The student should be able to identify the parts of the torch body and cutting attachment, list purposes of a slag box, describe the results of a backfire and a flashback, and perform cutting skills with the cutting torch by making ninety degree cuts, level cuts, and cut holes in mild steel. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene cutting to the correct definitions.
2. List safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.
3. Identify the parts of the torch body and cutting attachment.
4. Identify parts of the oxyacetylene cutting outfit.
5. List purposes of slag box.
6. List reasons for poor cuts.
7. List the causes of backfire.
8. Describe the results of a backfire.
9. Describe the results of flashback.
10. Arrange in the proper order the steps to follow in case of flashback.
11. Distinguish between the advantages and disadvantages of LP gas cutting.
12. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene cutting.
    b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

c. Make ninety degree cuts on mild steel and restart a cut.

d. Make flame-beveled cut on mild steel plate.

e. Cut hole in mild steel.

f. Cut orange peel.

g. Lay out pattern on mild steel plate.

h. Cut saddle joints.

OXYACETYLENE CUTTING
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  G. Give test.

II. Unit references:

  A. *Instructional Materials for Vocational Agriculture I.* College Station, Texas: Teaching Materials Center, Agricultural Education Department, Texas A&M University.

  B. Sneep, Neil O. *Vocational Agriculture Training Programs: Safe Tractor Operation and Safe Farm Machinery Operation.* East Lansing, Michigan: Rural Manpower Center, Michigan State University, 1969.

  C. Schmidt, A. W.; Witt, D. J.; Mills, Loren; and Pearson, Charles. *Safe Practices in the Vocational Agriculture Shop.* Urbana, Illinois: Teachers of Vocational Agriculture, State of Illinois.

  D. Cook, George. "Test Materials Handout and Job Sheets." Prepared by the Agricultural Engineering 4220 class, Summer. Stillwater: Oklahoma State University, 1963.

  E. Williams, William A. *Accident Prevention Manual for Shop Teachers.* Chicago, Illinois: American Technical Society, 1963.

  F. *Best's Safety Directory.* Morriston, New Jersey: A. M. Best Co., 1968.

  G. Ross, Henry, and Craig, R. N. *Modern Farm Shop.* Austin, Texas: Steck-Vaughn Co., 1954.

H. *A Guide for Course Planning in Introduction to Agriculture.* Raleigh, North Carolina: Division of Vocational Education, Agricultural Education Section, Department of Public Instruction.

I. Hollenberg, A. H. *How To Teach Arc Welding in Farm Mechanics.* Columbus, Ohio: The James F. Lincoln Arc Welding Foundation, 1958.

J. Hoover, Norman K. *Handbook of Agricultural Occupations.* Danville, Illinois: Interstate Printers and Publishers, 1963.

K. Oklahoma. *State Law 824,* Section 1407. 1970.

L. Phipps, Lloyd J. *Mechanics in Agriculture.* Danville, Illinois: Interstate Printers and Publishers, Inc., 1970.

OXYACETYLENE CUTTING
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Flashback--Fire inside torch

(CAUTION: This is a very dangerous condition.)

B. Backfire--Momentary burning back of the flame into the tip

C. Flame cutting--Process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high oxygen flowing under pressure through a cutting torch

(NOTE: As the metal is oxidized, the preheat flame maintains the temperature necessary to keep the oxidation process going in a narrow zone across the length of the base metal.)

D. Slag box--Metal container with a layer of water or sand to catch hot slag

E. Drag line--Situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

F. Kerf--Area where the metal was removed in the form of an oxide during the cutting process

G. Oxide--Rust, corrosion, coating, film, or scale

(NOTE: Oxygen combines with the metal causing oxides.)

H. Oxidizing--Combining oxygen with another substance

Example: Metal is oxidized when the metal is cut

II. Safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment

A. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

(NOTE: Acetylene gas is in a liquid state in the cylinder and should be used in the vertical position so the acetone will not be withdrawn.)

INFORMATION SHEET

B. Blow out cylinder valves in order to remove dust and dirt that may damage regulators

(NOTE: Be sure to crack cylinder valves for a second before attaching regulators.)

C. Release pressure adjusting screw on regulator before opening cylinder valve to prevent damage to regulator and possible injury to operator

D. Stand to the side of regulator, keeping the cylinder valve between operator and regulator while opening cylinder valve

E. Open cylinder valve slowly

F. Do not use acetylene (in free state) at pressures higher than 15 psi

(NOTE: Acetylene becomes unstable at pressures above 15 psi and becomes highly explosive.)

G. Clear oxygen and acetylene passages individually before lighting torch

H. Light acetylene before opening oxygen torch valve

I. Never use oil or grease on regulators, torches, or fittings

(NOTE: Oil or grease and oxygen have a very great attraction for one another and will unite with explosive violence.)

J. Do not use oxygen as a substitute for compressed air

K. Use safety goggles, gloves, and protective clothing

(NOTE: Keep gloves, hands, and clothing free from oil and grease.)

L. Have CO_2 or dry powder type fire extinguisher available

M. Test connections for leaks with Ivory soapsuds, paint brush, and water

N. Avoid lighting torch or welding near combustible material

O. Never open the acetylene cylinder valve more than 1/2 to 3/4 turn

P. Always operate torch in a well-ventilated place

Q. Never weld on containers that have been used for combustible materials

INFORMATION SHEET

R. Avoid breathing toxic fumes when welding

Example: Galvanized metal

S. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

T. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on equipment

U. Turn off acetylene torch valve first so flame will go out immediately

V. Never cut or weld near concrete

W. Always weld or cut at least five feet from cylinder

X. Always protect hoses from hot metal, rupture, or mechanical damage

Y. Always light torch with friction lighter

Z. Never leave a burning torch unattended

(NOTE: The instructor may want to add other safety rules.)

III. Parts of a torch body and cutting attachment (Transparency 1)

A. Cutting torch

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve
4. Acetylene torch valve
5. Torch body
6. Oxygen cutting lever
7. Oxygen preheat valve
8. Tip nut
9. Tip

INFORMATION SHEET

B. Cutting tip

1. Preheat orifice

(NOTE: The preheat orifice heats metal to kindling point [cherry red], approximately 1600°F.)

2. Cutting orifice

(NOTE: The cutting orifice removes oxidized metal. The selection of the correct tip for the job is determined by the thickness of metal, size of tip orifices, and the oxygen cutting pressures. See manufacturer's recommendations.)

IV. Parts of the oxyacetylene cutting outfit (Transparencies 2 and 3)

A. Oxygen cylinder
B. Oxygen cylinder valve
C. Acetylene cylinder
D. Acetylene cylinder valve
E. Acetylene regulator
F. Oxygen regulator
G. Cylinder truck
H. Safety chain
I. Acetylene fitting
J. Acetylene torch valve
K. Oxygen fitting
L. Oxygen torch valve
M. Torch body
N. Cutting attachment
O. Oxygen cutting lever
P. Oxygen preheat valve
Q. Tip nut
R. Tip

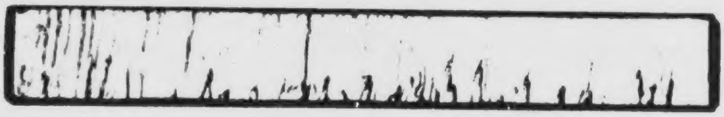
V. Purposes of slag box

A. To catch hot slag
B. To prevent fire
C. To protect clothing
D. To protect welding hoses

VI. Reasons for poor cuts

A. Preheat flames were to small

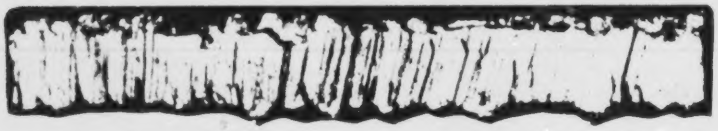
(NOTE: The cutting speed was too slow, causing bad gouging at the bottom.)



INFORMATION SHEET

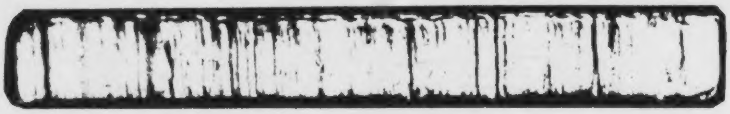
B. Preheat flames were too long

(NOTE: The top-surface has melted over, the cut edge is irregular, and there is an excessive amount of adhering slag.)



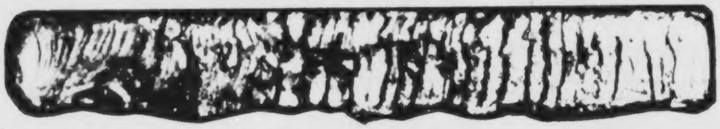
C. Oxygen pressure was too low

(NOTE: The top edge has melted over because of the too slow cutting speed.)



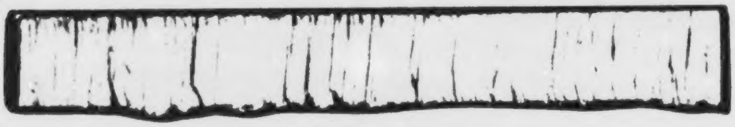
D. Oxygen pressure was too high and the nozzle size too small

(NOTE: The entire control of the cut has been lost.)



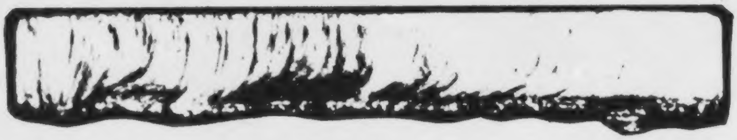
E. Cutting speed was too slow

(NOTE: The irregularities of the draglines are emphasized.)



F. Cutting speed was too high

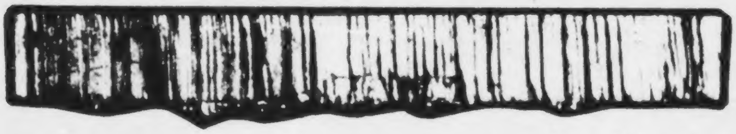
(NOTE: There is a pronounced break to the dragline and the cut edge is irregular.)



INFORMATION SHEET

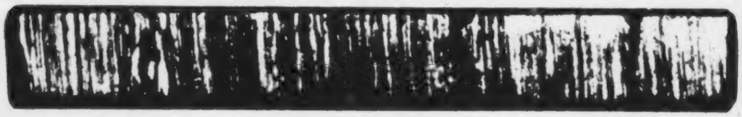
G. Blowpipe travel was unsteady

(NOTE: The cut edge is wavy and irregular.)

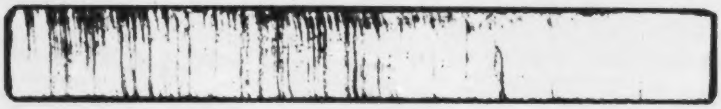


H. Cut was lost and not carefully restarted

(NOTE: Bad gouges were caused at the restarting point.)



(NOTE: THIS IS A CORRECTLY MADE CUT IN ONE INCH PLATE; THE EDGE IS SQUARE AND THE DRAG LINES ARE ESSENTIALLY VERTICAL AND NOT TOO PRONOUNCED.)



VII. Causes of backfire

A. Insufficient acetylene or oxygen pressure

B. Loose cutting tip

C. Dirty tip

D. Overheating of cutting tip

E. Bad O-ring in torch body

(NOTE: The above causes should be carefully checked to control backfire.)

VIII. Results of a backfire

A. Flame burns momentarily back into tip

B. Loud snap or pop results

1. Flame may go out
2. Flame may continue to burn in normal manner

INFORMATION SHEET

IX. Results of flashback

- A. Fire inside torch
- B. Disappearance of flame followed by
  - 1. Squealing or hissing noise inside torch
  - 2. Sparks coming from the torch
  - 3. Smoke coming from the torch

X. Steps to follow in case of flashback

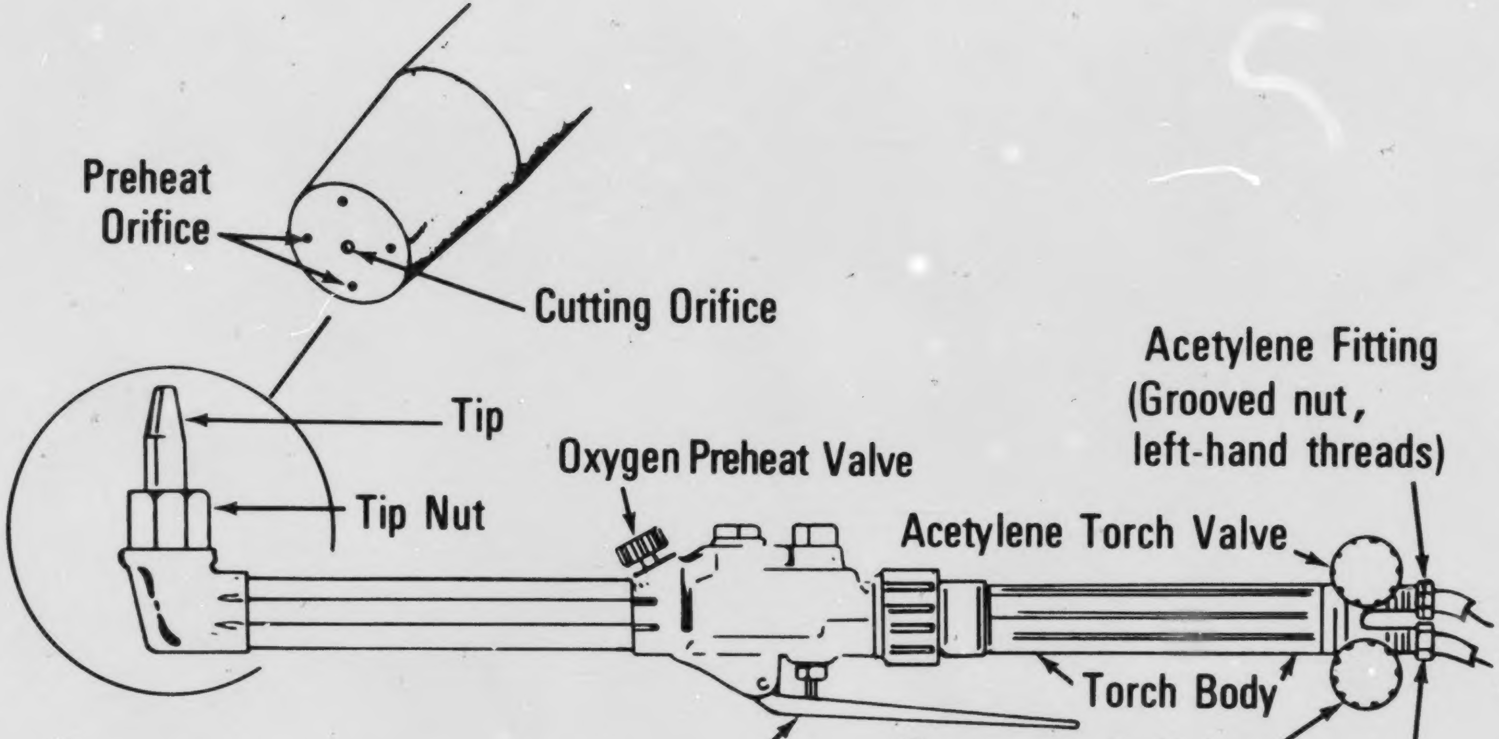
- A. Close oxygen preheat valve
- B. Close oxygen torch valve
- C. Close acetylene torch valve
- D. Release oxygen regulator screw
- E. Release acetylene regulator screw
- F. Examine acetylene unit
- G. Reset regulator pressures
- H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen cylinder valve and the acetylene cylinder valve, then notify your instructor.)

XI. LP gas cutting

- A. Advantages
  - 1. Gas is easier to obtain
  - 2. Galvanized metal can be cut without clogging the tip
  - 3. Cylinders are cheaper and easier to obtain
- B. Disadvantages
  - 1. Requires about three times as much oxygen as acetylene to produce the same amount of heat
  - 2. Requires different regulators and tips
  - 3. Can not use LP gas for fusion welding
  - 4. Is more expensive

Parts of a Torch Body and Cutting Attachment



Preheat Orifice

Cutting Orifice

Tip

Tip Nut

Oxygen Preheat Valve

Acetylene Fitting (Grooved nut, left-hand threads)

Acetylene Torch Valve

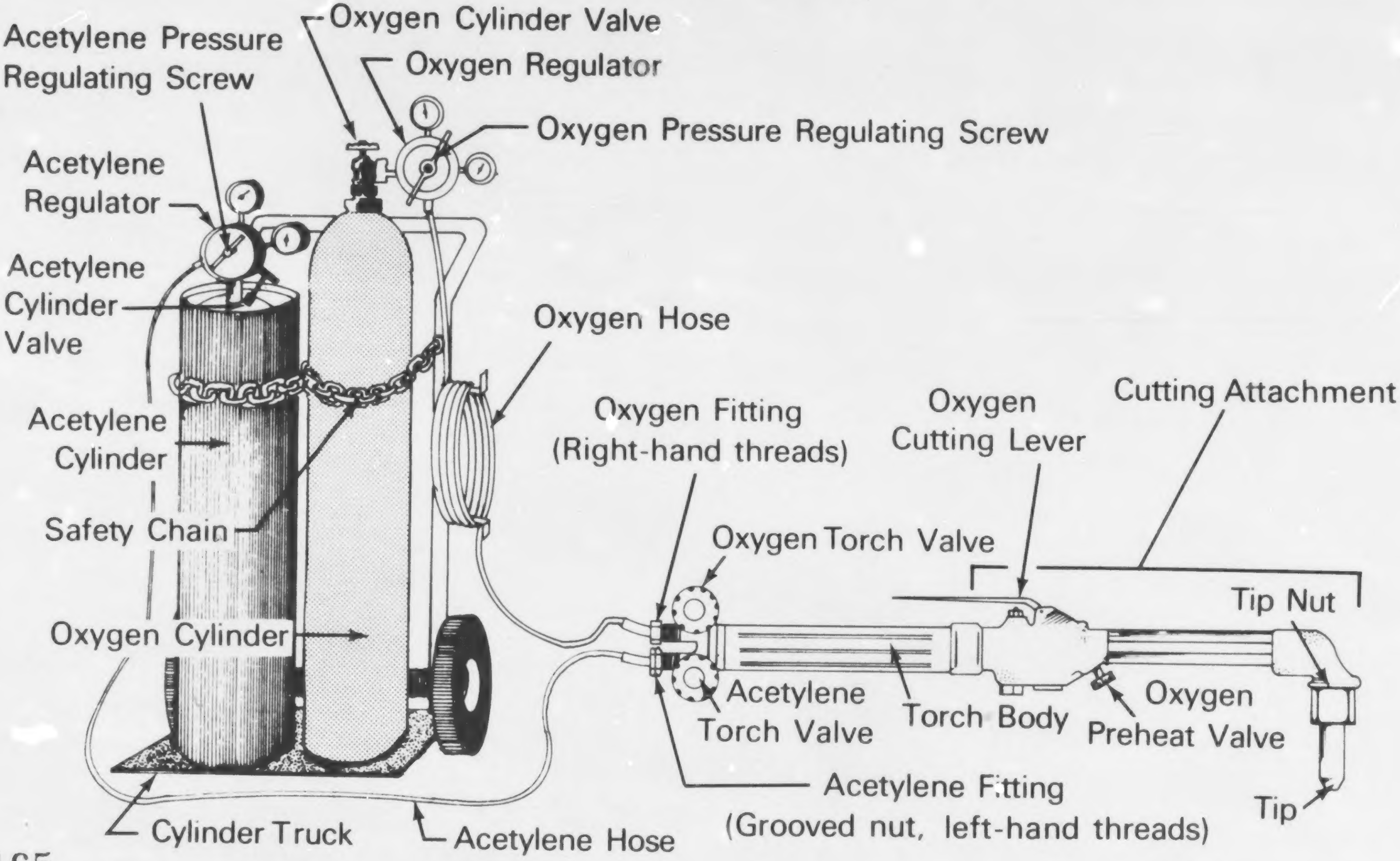
Torch Body

Oxygen Torch Valve

Oxygen Cutting Lever

Oxygen Fitting (Right-hand threads)

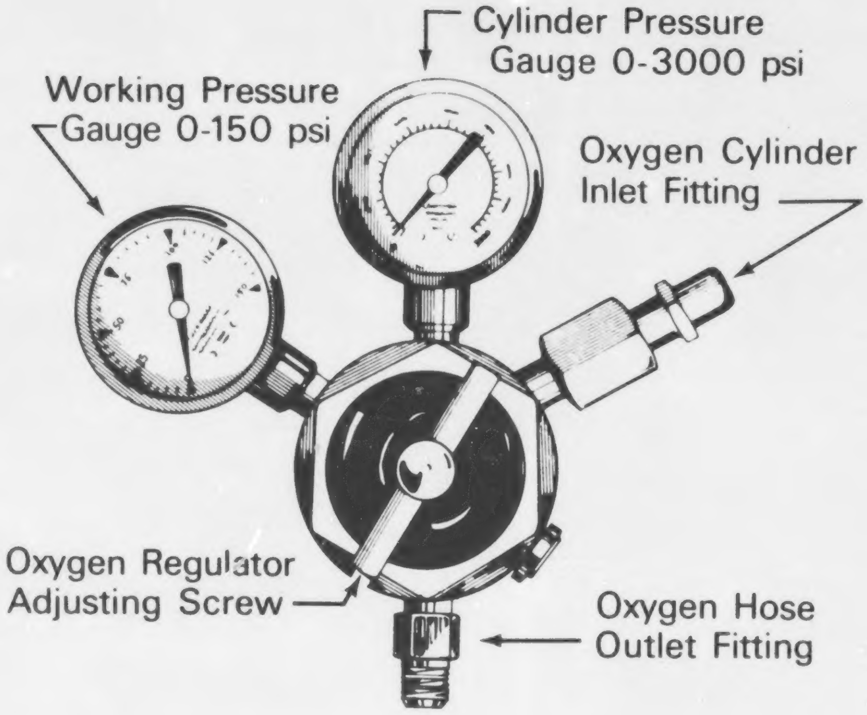
Oxyacetylene Cutting Outfit


Oxygen Cylinder Valve
Acetylene Pressure Regulating Screw
Oxygen Regulator
Oxygen Pressure Regulating Screw
Acetylene Regulator
Acetylene Cylinder Valve
Oxygen Hose
Acetylene Cylinder
Cutting Attachment
Oxygen Fitting (Right-hand threads)
Oxygen Cutting Lever
Safety Chain
Oxygen Torch Valve
Tip Nut
Oxygen Cylinder
Acetylene Torch Valve
Torch Body
Oxygen Preheat Valve
Acetylene Fitting (Grooved nut, left-hand threads)
Tip
Cylinder Truck
Acetylene Hose

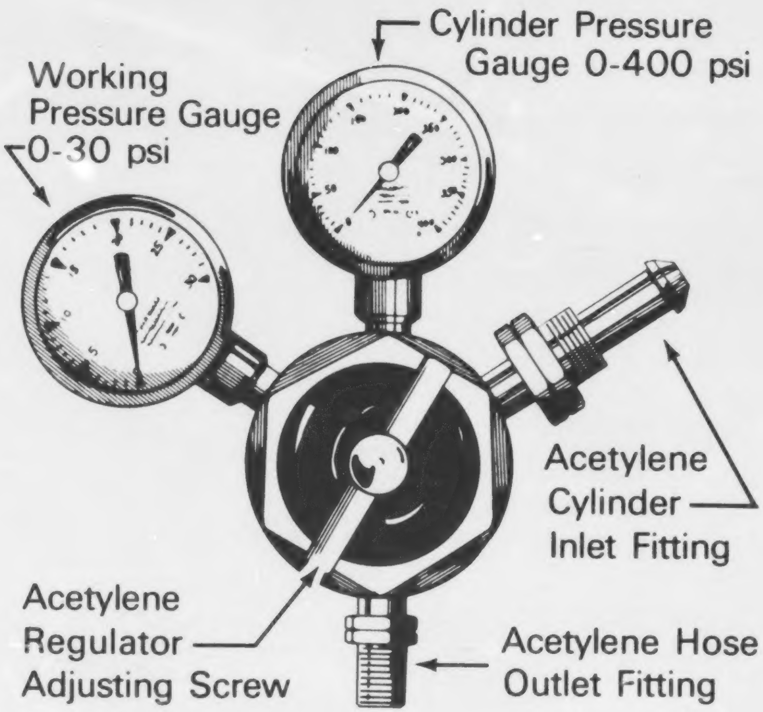
TM 2

AgM - 147-B

Welding Regulators


Cylinder Pressure Gauge 0-3000 psi
Working Pressure Gauge 0-150 psi
Oxygen Cylinder Inlet Fitting
Oxygen Regulator Adjusting Screw
Oxygen Hose Outlet Fitting

Oxygen Regulator


Cylinder Pressure Gauge 0-400 psi
Working Pressure Gauge 0-30 psi
Acetylene Cylinder Inlet Fitting
Acetylene Regulator Adjusting Screw
Acetylene Hose Outlet Fitting

Acetylene Regulator

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE CUTTING

I. Tools and materials

   A. Oxygen cylinder

   B. Acetylene cylinder

   C. Oxygen regulator

   D. Acetylene regulator

   E. Hoses

   F. Wrench

   G. Cylinder holder

   H. Water container

   I. Ivory soap

   J. Clean paint brush

   K. Torch body with tips

II. Procedure

   A. Fasten cylinders in a vertical position

   B. Remove caps from cylinders

   C. Crack valves of each cylinder, then close valves

   D. Connect oxygen regulator to oxygen cylinder

      1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

      2. Slowly turn cylinder valve wide open

   E. Connect acetylene regulator to acetylene cylinder

      1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

      2. Open cylinder valve 1/2 to 3/4 of a turn

         (CAUTION: The cylinder valve should never be opened more than 1 1/2 turns.)

JOB SHEET #1

F. Connect acetylene hose to acetylene regulator and purge hose

G. Connect oxygen hose to oxygen regulator and purge hose

H. Connect torch body to oxygen and acetylene hose and close both valves on torch body

I. Attach cutting attachment to torch body

(NOTE: The tip size is determined by the thickness of metal to be cut and the manufacturer's recommendations.)

J. Close oxygen preheat valve on cutting attachment

K. Turn adjusting screw on oxygen regulator clockwise until working pressure is reached

L. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached

M. Test all connections for leaks with Ivory soapsuds and water

(NOTE: Apply soapsuds with a clean paint brush.)

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #2--TURN ON, LIGHT, ADJUST TO A NEUTRAL FLAME, AND TURN OFF THE OXYACETYLENE CUTTING EQUIPMENT

I. Tools and materials

   A. Oxygen cylinder

   B. Acetylene cylinder

   C. Hoses

   D. Oxygen and acetylene regulators

   E. Torch body

   F. Cutting attachment with slip-in tip

   G. Cylinder holder and hose rack

   H. Flint lighter

   I. Wrench

   J. Gloves

   K. Safety goggles

   L. Coveralls or protective clothing

II. Procedure

   A. Check all cylinder, regulator, and torch valves to make sure they are off

   B. Open acetylene cylinder valve 1/2 to 3/4 of a turn

   (CAUTION: The cylinder valve should never be opened more than 1 1/2 turns.)

   C. Open acetylene valve on torch one turn

   D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached

   (NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

JOB SHEET #2

E. Close acetylene valve on torch

F. Open oxygen cylinder valve all the way

G. Open oxygen torch valve all the way

H. Open oxygen preheat valve on cutting attachment one turn

I. Turn adjusting screw on regulator clockwise until desired pressure is reached

(NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

J. Close oxygen preheat valve on cutting attachment

K. Open acetylene valve on torch 1/4 turn

L. Light the torch with flint lighter and adjust until smoke on flame clears

M. Open oxygen preheat valve slowly and adjust to a neutral flame

N. Depress the oxygen cutting lever and check to see that a neutral flame is present

(NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.)

O. Close acetylene valve on torch

P. Close oxygen preheat valve

Q. Close acetylene cylinder valve

R. Close oxygen cylinder valve

S. Open acetylene valve on torch

(NOTE: When gauges reach O, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.)

T. Open oxygen preheat valve on torch

(NOTE: When gauges reach O, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.)

U. Close oxygen valve on torch

V. Place torch and hose on hanger or brackets provided

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #3--MAKE NINETY DEGREE CUTS ON MILD STEEL AND RESTART A CUT

I. Tools and materials

   A. Cutting outfit with tip assembly

   B. Mild steel plate, 1/4"-1/2" thick x 4" wide or wider x 8" long or longer

   C. Soapstone with a sharp point or edge

   D. Straightedge

   E. Gloves

   F. Safety goggles

   G. Pliers

   H. Coveralls

   I. Flint lighter

   J. Welding or cutting table

   K. Slag box

   L. Can of water

   M. Cutting tip

II. Procedure

   A. Make a ninety degree cut

      1. Mark four parallel lines 2" apart on plate to be cut

      2. Adjust oxygen regulator

      3. Adjust acetylene regulator

      4. Place plate to be cut over slag box

      5. Light torch

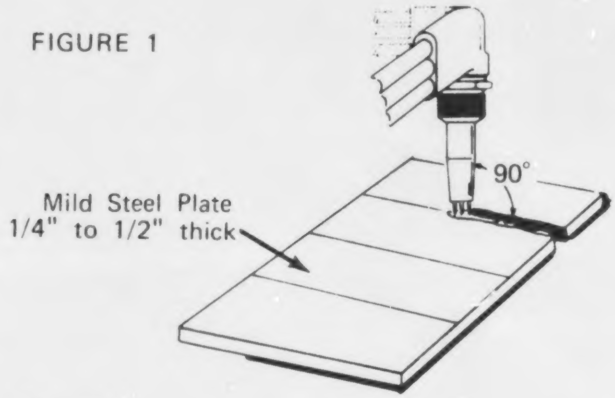
      6. Adjust to neutral flame

JOB SHEET #3

7. Assume comfortable position
8. Place hoses behind operator
9. Maneuver torch with both hands
10. Hold preheat flame with tip of inner cone 1/16" to 1/8" above top of plate at right edge until red spot appears
11. Depress the oxygen cutting lever and move from right to left across the plate (Figure 1)

    (NOTE: For left-handed operators, go from left to right.)

FIGURE 1



12. Hold the tip at right angles to work while cutting with inner cone being 1/16" to 1/8" above work
13. Make 90° cuts until you have developed the proper procedure
14. Cool metal by placing in can of water with the aid of pliers

    (NOTE: Show samples to instructor for approval and grading.)

B. Restart a cut

1. Release the oxygen cutting lever
2. Preheat only the edge where cutting action was stopped
3. Slowly depress oxygen cutting lever and continue cut

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #4--MAKE FLAME-BEVELED CUT ON MILD STEEL PLATE

I. Tools and materials

   A. Cutting outfit with tip assembly
   B. Mild steel plate, 1/4"-1/2" thick x 4" wide or wider x 8" long or longer
   C. Soapstone with a sharp point or edge
   D Straightedge
   E. Gloves
   F. Safety goggles
   G. Pliers
   H. Coveralls
   I. Flint lighter
   J. Welding or cutting table
   K. Slag box
   L. Can of water
   M. Cutting tip

II. Procedure

   A. Place one piece of 3/8" to 1/2" plate 2" x 6" on slag box or cutting table
   B. Light and adjust cutting torch to a neutral flame

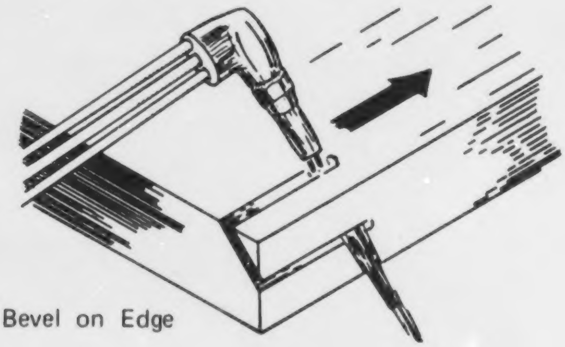
   (NOTE: Oxygen cutting pressures are greater for bevel cuts than 90° cuts.)

   C. Place hoses behind operator

JOB SHEET #4

D. Hold torch with both hands at desired angle to metal (Figure 1)

FIGURE 1



E. Hold preheat flame with tip of inner cone (neutral flame) 1/16" to 1/8" above top of plate until bright red spot appears

F. Depress oxygen cutting lever and proceed across plate with very consistent movement being careful to maintain constant travel speed, torch angle, and flame to work distance

(NOTE: Practice until you develop the proper procedure. Turn in exercises for instructor's approval and grading.)

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #5--CUT HOLE IN MILD STEEL

I. Tools and materials

  A. Cutting outfit with tip

  B. Mild steel plates

  C. Soapstone with a sharp point or edge

  D. Straightedge

  E. Gloves

  F. Safety goggles

  G. Pliers

  H. Coveralls

  I. Flint lighter

  J. Welding or cutting table

  K. Slag box

  L. Can of water

II. Procedure

  A. Draw two circles on metal

    1. 1" in diameter, 1" from edge

    2. 1/2" in diameter, 1" from edge

  B. Adjust oxygen regulator

  C. Adjust acetylene regulator

  D. Place metal to be cut over slag box

  E. Light torch

  F. Adjust to neutral flame

  G. Assume comfortable position

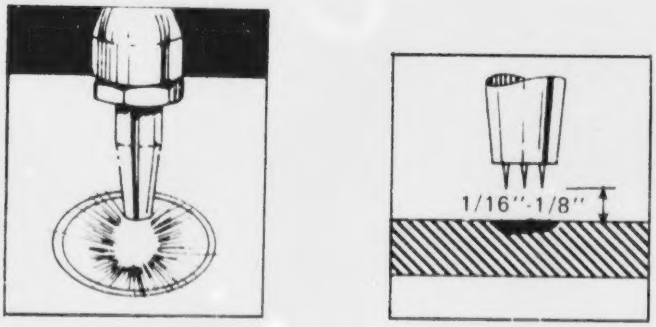
  H. Place hoses behind operator

JOB SHEET #5

I. Maneuver torch with both hands

J. Hold tip of inner cone 1/16" to 1/8" above point to be cut until metal turns bright red in the center of circle (Figure 1)

FIGURE 1

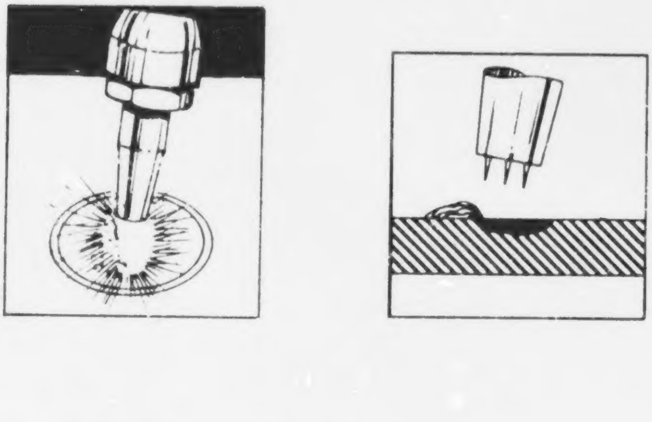


1. Tilt torch 15° from vertical position (Figure 2)

   (NOTE: This will allow molten metal to be blown away from operator.)

2. Depress oxygen cutting lever slowly, moving torch backwards (to the operator's right if right-handed) until cut pierces plate (Figure 2)

FIGURE 2

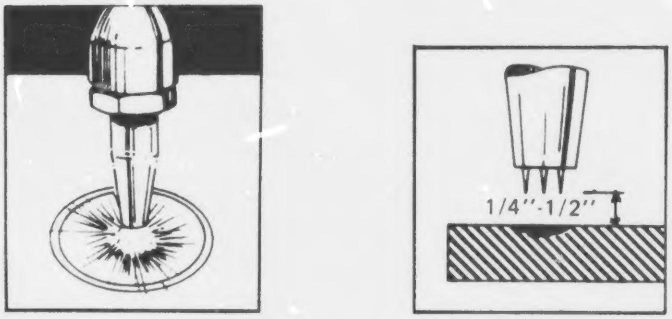


JOB SHEET #5

K. Return cutting torch to vertical position

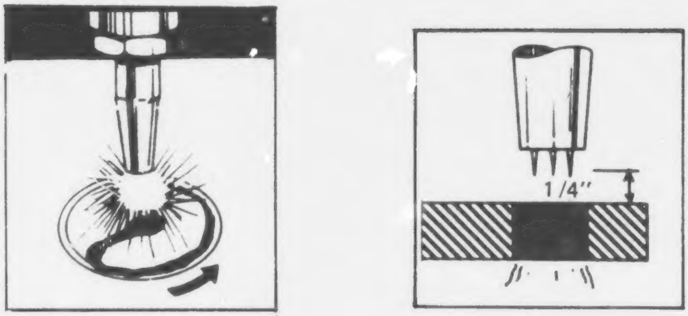
  1. Raise cutting tip until tip of inner cone is from 1/4" to 1/2" above the plate (Figure 3)

FIGURE 3



  2. Make cut (Figure 4)

FIGURE 4



L. Cut just inside soapstone mark until circular cut is completed

M. Repeat steps K and L until all holes are cut

N. Cool metal by placing in can of water with the aid of pliers

(NOTE: Show samples to instructor for approval and grading.)

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #6--CUT ORANGE PEEL

I. Tools and materials

- A. Oxyacetylene cutting apparatus
- B. Chalk or soapstone
- C. Tape measure
- D. Paper for template
- E. Pipe, 6" long

II. Procedure

A. Determine from the table the number of arms for the size of pipe (Figure 1)

FIGURE 1

ORANGE-PEEL DATA

Pipe size, in Inches	No. of Arms	A, in Inches	B, in Inches	C, in Inches	E, in Inches
1 1/2	4	1 1/2	1 1/2	1 5/16	3/4
2	4	1 7/8	1 7/8	1 5/8	15/16
2 1/2	4	2 1/4	2 1/4	1 31/32	1 1/8
3	4	2 3/4	2 3/4	2 13/32	1 3/8
3 1/2	4	3 1/8	3 1/8	2 3/4	1 9/16
4	4	3 1/2	3 17/32	3 1/16	1 3/4
5	5	4 3/8	3 1/2	3 1/16	1 3/4
6	5	5 1/4	4 1/8	3 5/8	2 1/16
8	5	6 3/4	5 3/8	4 3/4	2 11/16
10	7	8 1/2	4 13/16	4 1/4	2 3/8
12	8	10	5	4 3/8	2 1/2

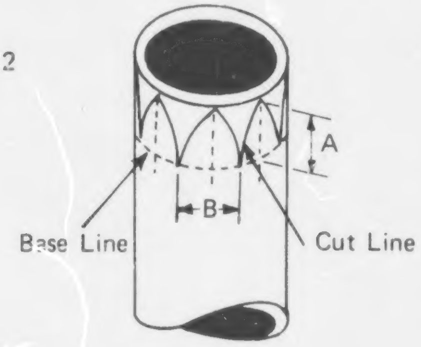
B. Divide the outside surface of the pipe near the end into the number of parts equal to the number of arms; then draw lines back from the end of the pipe at these division points

(NOTE: These lines are reference lines. Templates can be purchased.)

JOB SHEET #6

C. Measure off distance A (Figure 1) from the end of the pipe; then draw the base line around the pipe at the point marked off (Figure 2)

FIGURE 2

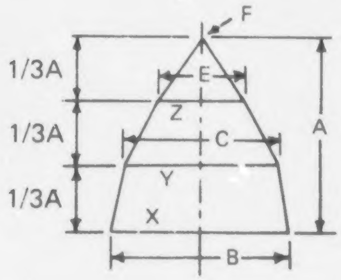


Layout on Pipe

D. Draw a template for one arm on a piece of paper (Figure 3)

1. Draw a straight line equal in length to dimension A
2. Divide the line into three equal parts
3. Draw lines on these three points at right angles to the center line
4. Obtain dimensions E, B, and C from the table (Figure 1) and lay them off on lines X, Y, and Z
5. Connect the ends of these lines and point F with straight lines
6. Cut out the template with a knife or scissors

FIGURE 3



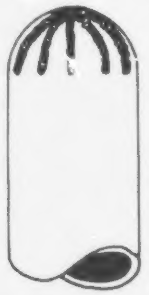
Template

JOB SHEET #6

E. Place the template on the pipe lining up the center line of the template with one of the reference lines, then mark around the template with soapstone to lay out one arm; repeat this process on all reference lines to lay out the arms necessary to make the complete orange peel (Figure 4)

(NOTE: When cutting, use a radial cut, that is, point the torch to the center of the pipe at all times. Bevel the edges of all arms to a 45° degree angle, then heat the arms and bend them into shape.)

FIGURE 4



Completed Orange Peel

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #7--LAY OUT PATTERN ON MILD STEEL PLATE

I. Tools and materials

   A. Square and straightedge

   B. Soapstone

   C. Mild steel plate, 1/4"-1/2" thick and 6" square

   D. Gloves

   E. Safety goggles

   F. Coveralls or protective clothing

II. Procedure

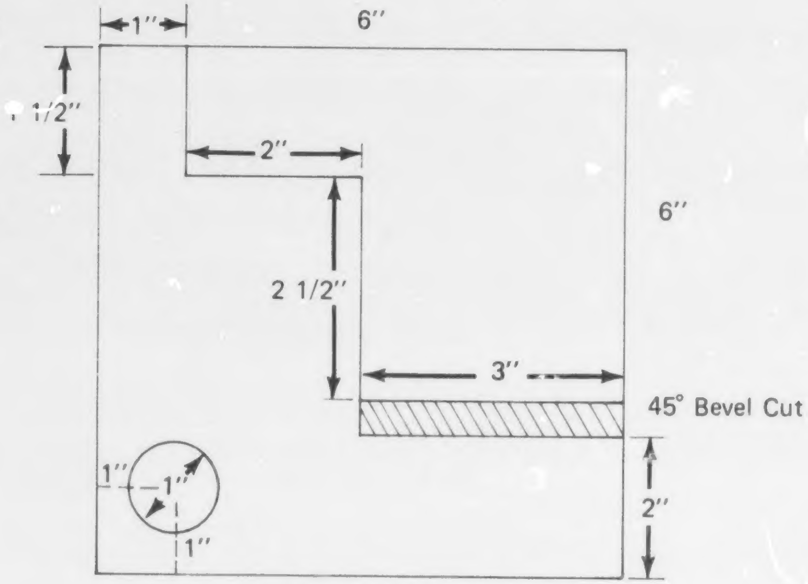
   A. Select starting point

   B. Measure distances and mark

   C. Complete drawing (Figure 1)

   (NOTE: Turn in to instructor for evaluation.)

FIGURE 1



OXYACETYLENE CUTTING
UNIT III

JOB SHEET #8--CUT SADDLE JOINTS

I. Tools and materials

   A. Cutting outfit with tip assembly

   B. Pipe, 2" in diameter

   C. Soapstone with a sharp point or edge

   D. Straightedge

   E. Steel tape

   F. Cutting table

   G. Gloves

   H. Safety goggles

   I. Coveralls

   J. Pliers

   K. Flint lighter

   L. Slag box

   M. Can of water

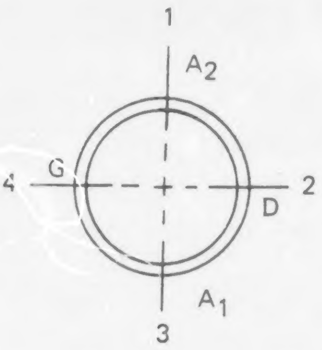
   N. Cutting tip

II. Procedure

   A. Measure the outside diameter of pipe

   B. Quarter the pipe by marking top, bottom, and sides (Figure 1)

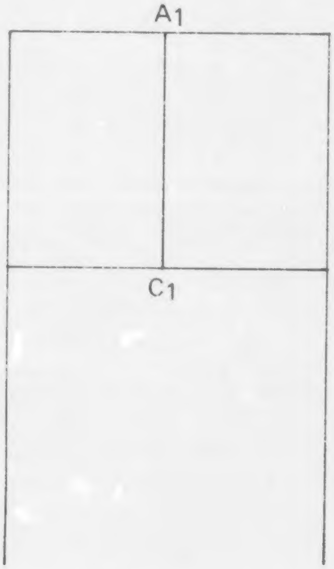
FIGURE 1



JOB SHEET #8

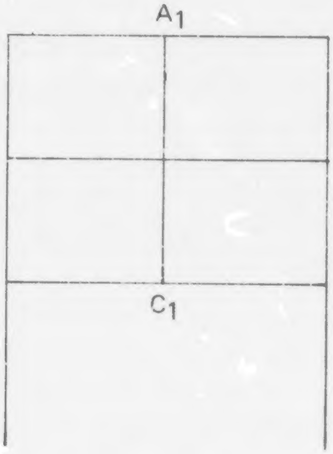
C. Measure from point A_1 to point C_1 a distance equal to the outside diameter of pipe (Figure 2)

FIGURE 2



D. Divide the measured distance between points A_1 and C_1 in half (Figure 3)

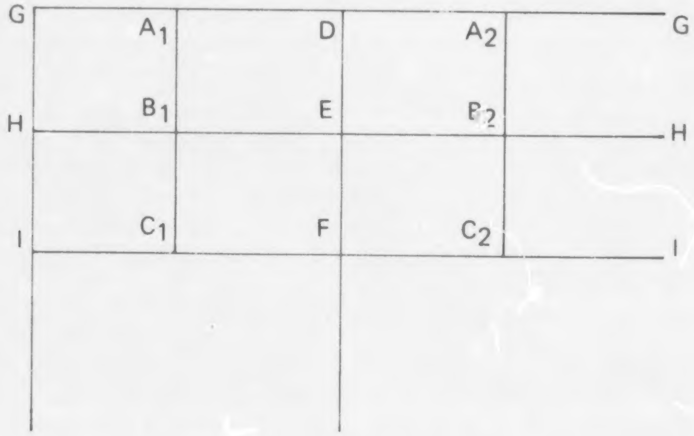
FIGURE 3



JOB SHEET #8

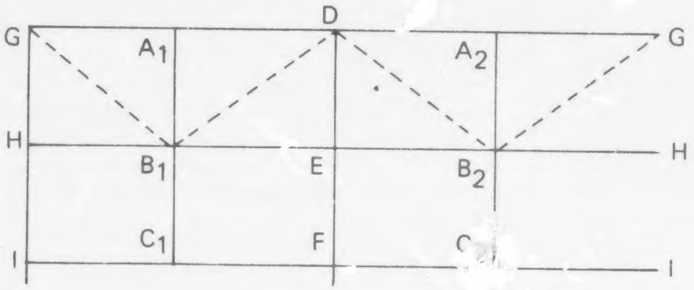
E. Label and draw lines on pipe (Figure 4)

FIGURE 4


G
A1
D
A2
G
H
B1
E
B2
H
I
C1
F
C2
I

F. Mark off saddle by drawing a line from point G to B_1 to D to B_2 and back to point G (Figure 5)

FIGURE 5


D
G
A1
A2
G
H
B1
E
B2
H
C1
F
C2
I
I

G. Cut saddle following dotted line (Figure 5)

OXYACETYLENE CUTTING
UNIT III

TEST

NAME ______________________________ SCORE ____________________

1. Match the terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided.

____a. Area where the metal was removed in the form of an oxide during the cutting process

____b. Momentary burning back of the flame into the tip

____c. Metal container with a layer of water or sand to catch hot slag

____d. Combining oxygen with another substance

____e. Process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high oxygen flowing under pressure through a cutting torch

____f. Fire inside torch

____g. Situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

____h. Rust, corrosion, coating, film, or scale

1. Flashback
2. Backfire
3. Flame cutting
4. Slag box
5. Drag line
6. Kerf
7. Oxide
8. Oxidizing

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

3. Identify the parts of the torch body and cutting attachment by writing the correct names in the blanks provided.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

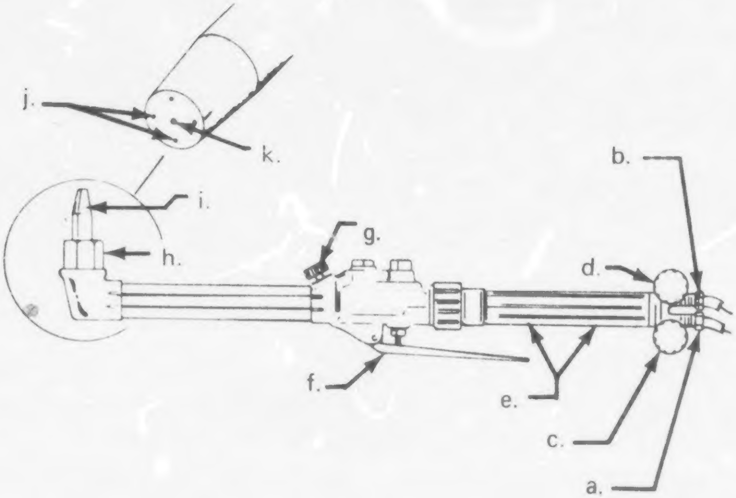
g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

k. ______________________________



4. Identify the parts of the oxyacetylene cutting outfit by writing the correct names in the blanks provided.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

i. ______________________

j. ______________________

k. ______________________

l. ______________________

m. ______________________

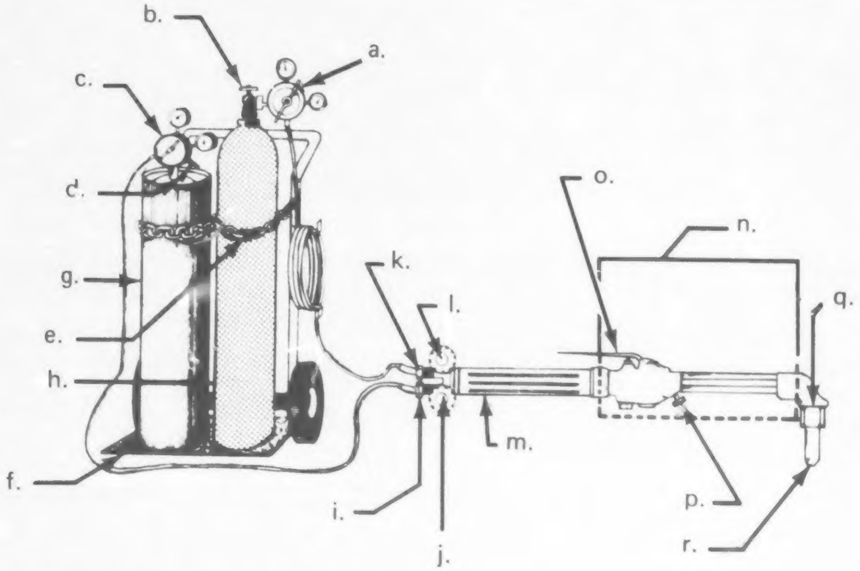
n. ______________________

o. ______________________

p. ______________________

q. ______________________

r. ______________________


b.
a.
c.
d.
g.
e.
h.
f.
i.
j.
k.
l.
m.
o.
n.
q.
p.
r.

5. List the purposes of a slag box.

a. ____

b. ____

c. ____

d. ____

6. List five reasons for poor cuts.

a. ____

b. ____

c. ____

d. ____

e. ____

7. List four causes of a backfire.

a. ____

b. ____

c. ____

d. ____

8. Describe the results of a backfire.

____

____

____

____

____

____

9. Describe the results of a flashback.

____

____

____

____

____

____

10. Arrange in the proper order the steps to follow in case of a flashback. Place a "1" in front of the first step, a "2" in front of the second, and so on.

_____a. Close oxygen torch valve

_____b. Release oxygen regulator screw

_____c. Examine acetylene unit

_____d. Light torch

_____e. Close oxygen preheat valve

_____f. Close acetylene torch valve

_____g. Release acetylene regulator screw

_____h. Reset regulator pressures

11. Distinguish between the advantages and disadvantages of LP gas cutting by placing an "X" before each advantage.

_____a. Gas is easier to obtain

_____b. Requires about three times as much oxygen as acetylene to produce the same amount of heat

_____c. Galvanized metal can be cut without clogging tip

_____d. Cylinders are cheaper and easier to obtain

_____e. Requires different regulators and tips

_____f. Is more expensive

_____g. Can not use LP gas for fusion welding

12. Demonstrate the ability to:

a. Set up equipment for oxyacetylene cutting.

b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

c. Make ninety degree cuts on mild steel and restart a cut.

d. Make flame-beveled cut on mild steel plate.

e. Cut hole in mild steel.

f. Cut orange peel.

g. Lay out pattern on mild steel plate.

h. Cut saddle joints.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE CUTTING
UNIT III

ANSWERS TO TEST

1. Match the terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided.

   __6__ a. Area where the metal was removed in the form of an oxide during the cutting process

   __2__ b. Momentary burning back of the flame into the tip

   __4__ c. Metal container with a layer of water or sand to catch hot slag

   __8__ d. Combining oxygen with another substance

   __3__ e. Process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high oxygen flowing under pressure through a cutting torch

   __1__ f. Fire inside torch

   __5__ g. Situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

   __7__ h. Rust, corrosion, coating, film, or scale

   1. Flashback
   2. Backfire
   3. Flame cutting
   4. Slag box
   5. Drag line
   6. Kerf
   7. Oxide
   8. Oxidizing

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

   (NOTE: Any ten of the following are acceptable.)

   a. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   b. Blow out cylinder valves in order to remove dust and dirt that may damage regulators

   c. Release pressure adjusting screw on regulator before opening cylinder valve to prevent damage to regulator and possible injury to operator

   d. Stand to the side of regulator, keeping the cylinder valve between operator and regulator while opening cylinder valve

e. Open cylinder valve slowly

f. Do not use acetylene (in free state) at pressures higher than 15 psi

g. Clear oxygen and acetylene passages individually before lighting torch

h. Light acetylene before opening oxygen torch valve

i. Never use oil or grease on regulators, torches, or fittings

j. Do not use oxygen as a substitute for compressed air

k. Use safety goggles, gloves, and protective clothing

l. Have CO_2 or dry powder type fire extinguisher available

m. Test connections for leaks with Ivory soapsuds, paint brush, and water

n. Avoid lighting torch or welding near combustible material

o. Never open the acetylene cylinder valve more than 1/2 to 3/4 turn

p. Always operate torch in a well-ventilated place

q. Never weld on containers that have been used for combustible materials

r. Avoid breathing toxic fumes when welding

s. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

t. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on equipment

u. Turn off acetylene torch valve first so flame will go out immediately

v. Never cut or weld near concrete

w. Always weld or cut at least five feet from cylinder

x. Always protect hoses from hot metal, rupture, or mechanical damage

y. Always light torch with friction lighter

z. Never leave a burning torch unattended

(NOTE: The instructor may want to add other safety rules.)

3. Identify the parts of the torch body and cutting attachment by writing the correct names in the blanks provided.

   a. Oxygen fitting

   b. Acetylene fitting

   c. Oxygen torch valve

   d. Acetylene torch valve

   e. Torch body

   f. Oxygen cutting lever

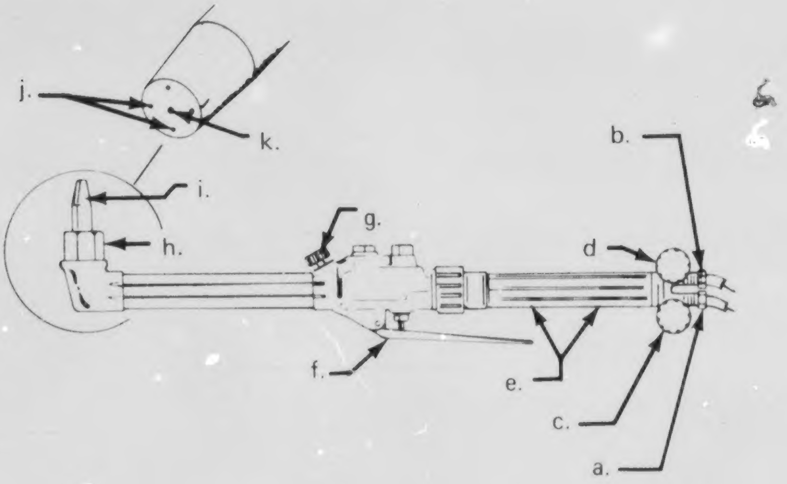
   g. Oxygen preheat valve

   h. Tip nut

   i. Tip

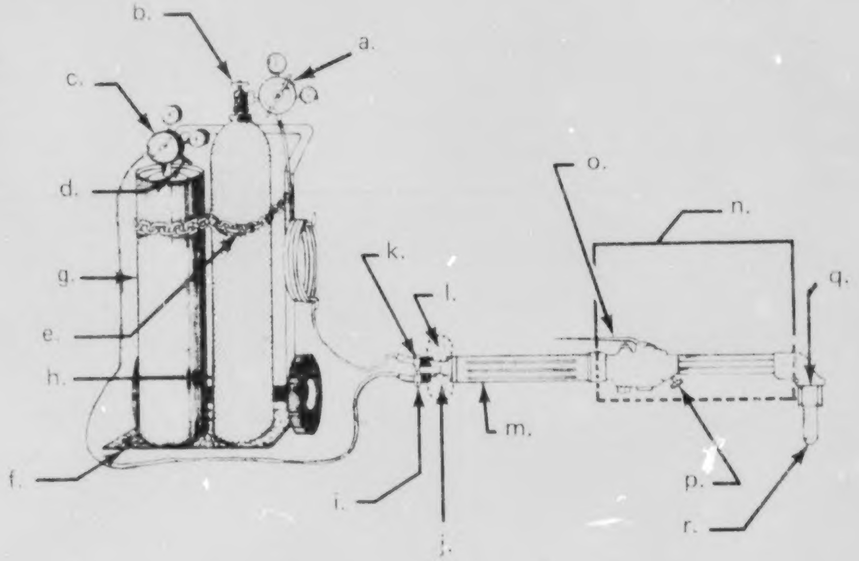
   j. Preheat orifice

   k. Cutting orifice



4. Identify the parts of the oxyacetylene cutting outfit by writing the correct names in the blanks provided.

   a. Oxygen regulator
   b. Oxygen cylinder valve
   c. Acetylene regulator
   d. Acetylene cylinder valve
   e. Safety chain
   f. Cylinder truck
   g. Acetylene cylinder
   h. Oxygen cylinder
   i. Acetylene fitting
   j. Acetylene torch valve
   k. Oxygen fitting
   l. Oxygen torch valve
   m. Torch body
   n. Cutting attachment
   o. Oxygen cutting lever
   p. Oxygen preheat valve
   q. Tip nut
   r. Tip



5. List the purposes of a slag box.

   a. To catch hot slag
   b. To prevent fire
   c. To protect clothing
   d. To protect welding hoses

6. List five reasons for poor cuts.

   (NOTE: Any five of the following are acceptable.)

   a. Preheat flames were too small
   b. Preheat flames were too long
   c. Oxygen pressure was too low
   d. Oxygen pressure was too high and nozzle size was too small
   e. Cutting speed was too slow
   f. Cutting speed was too high
   g. Blowpipe travel was unsteady
   h. Cut was lost and not carefully restarted

7. List four causes of a backfire.

   (NOTE: Any four of the following are acceptable.)

   a. Insufficient acetylene or oxygen pressure
   b. Loose cutting tip
   c. Dirty tip
   d. Overheating of cutting tip
   e. Bad O-ring in torch body

8. Describe the results of a backfire.

   a. Flame burns momentarily back into tip
   b. Loud snap or pop results
      1) Flame may go out
      2) Flame may continue to burn in normal manner

9. Describe the results of a flashback.

   a. Fire inside torch
   b. Disappearance of flame followed by
      1) Squealing or hissing noise inside torch
      2) Sparks coming from torch
      3) Smoke coming from torch

10. Arrange in the proper order the steps to follow in case of a flashback. Place a "1" in front of the first step, a "2" in front of the second, and so on.

__2__ a. Close oxygen torch valve

__4__ b. Release oxygen regulator screw

__6__ c. Examine acetylene unit

__8__ d. Light torch

__1__ e. Close oxygen preheat valve

__3__ f. Close acetylene torch valve

__5__ g. Release acetylene regulator screw

__7__ h. Reset regulator pressures

11. Distinguish between the advantages and disadvantages of LP gas cutting by placing an "X" before each advantage.

__X__ a. Gas is easier to obtain

_____ b. Requires about three times as much oxygen as acetylene to produce the same amount of heat

__X__ c. Galvanized metal can be cut without clogging tip

__X__ d. Cylinders are cheaper and easier to obtain

_____ e. Requires different regulators and tips

_____ f. Is more expensive

_____ g. Can not use LP gas for fusion welding

12. Demonstrate the ability to:

a. Set up equipment for oxyacetylene cutting.

b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

c. Make ninety degree cuts on mild steel and restart a cut.

d. Make flame-beveled cut on mild steel plate.

e. Cut hole in mild steel.

f. Cut orange peel.

g. Lay out pattern on mild steel plate.

h. Cut saddle joints.

(NOTE: The above performance skills should be evaluated to the satisfaction of the instructor.)

OXYACETYLENE FUSION WELDING
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to demonstrate the ability to turn on, light, adjust, and turn off oxyacetylene welding equipment and make welds with or without filler rod. The student should be able to select proper tip size and list factors that determine the correct type of filler rod. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene fusion welding to the correct definitions.
2. List safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.
3. Identify the parts of oxyacetylene fusion welding equipment.
4. Select from a list factors that determine weld quality.
5. List properties of a good weld.
6. Select from a list factors that determine tip size.
7. List the factors that determine filler rod selection.
8. State the purpose of a filler rod.
9. Classify oxyacetylene fusion welding flames.
10. Demonstrate the ability to:
    a. Turn on, light, adjust, and turn off oxyacetylene welding equipment.
    b. Construct a corner weld without filler rod.
    c. Lay beads on gauge metal without filler rod.
    d. Lay beads on gauge metal with filler rod.
    e. Weld butt joints with filler rod.
    f. Weld flat lap weld with filler rod.
    g. Weld tee or fillet weld with filler rod.

OXYACETYLENE FUSION WELDING
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  (NOTE: The instructor may want to secure films on oxyacetylene fusion welding from Curriculum and Instructional Materials Center to show to class.)

  G. Give test.

II. Unit references:

  A. *Smith's Instructor's Manual for a Basic Course in Oxyacetylene Brazing, Cutting, and Welding* (Form 424). Minneapolis, Minnesota: Smith Welding Equipment, Divison of Tescom Corporation.

  B. *Instructor's Answer Key* (Form 429). For use with *Smith's Instructor's Manual* (Form 424). Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.

  C. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook.* Danville, Illinois: Interstate Printers and Publishers, Inc.

  D. Althouse, Andrew D.; Turnquist, Carl H.; and Bowditch, William A. *Modern Welding.* Homewood, Illinois: Goodheart-Willcox Company, Inc., 1970.

  E. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division.

III. Films:

  (NOTE: Only Oklahoma teachers may order films and filmstrips from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1515 West Sixth, Stillwater, Oklahoma 74074. Out-of-state teachers may purchase and/or rent materials from the addresses listed.)

  A. "Oxyacetylene Welding Equipment." Available from BFA Educational Media, 2211 Michigan Avenue, Santa Monica, CA 90404.

B. "Oxyacetylene Welding: Torch Techniques." Available from BFA Educational Media, 2211 Michigan Avenue, Santa Monica, CA 90404.

OXYACETYLENE FUSION WELDING
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Fusion welding--Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   B. Penetration--Distance from the original surface of the base metal to that point at which fusion ceases

   C. Base metal--Metal to be welded

   D. Alloy--Mixture with metallic properties; composed of two or more elements of which at least one is a metal

   E. Inner cone--Inner white part of a neutral flame

   F. Tack weld--Short weld used for temporarily holding metal in place

   G. Backfire--Momentary burning back of the flame into the tip; flame goes out with a loud snap or pop

   H. Flashback--Fire inside the torch; indicated by a hissing or squealing sound

   (CAUTION: This is a very dangerous condition.)

   I. Check valve--Prevents the mixing of gases and removes hazard of explosion

II. Safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment

   A. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   (NOTE: Acetylene gas is in a liquid state in the cylinder and should be used in the vertical position so the acetone will not be withdrawn.)

   B. Blow out cylinder valves in order to remove dust and dirt that may damage regulators

   (NOTE: Be sure to crack cylinder valves for a second before attaching regulators.)

   C. Release pressure adjusting screw on regulator before opening cylinder valve to prevent damage to regulator and possible injury to operator

INFORMATION SHEET

D. Stand to the side of regulator, keeping the cylinder valve between operator and regulator while opening cylinder valve

E. Open cylinder valve slowly

F. Do not use acetylene (in free state) at pressures higher than 15 psi

(NOTE: Acetylene becomes unstable at pressures above 15 psi and becomes highly explosive.)

G. Clear oxygen and acetylene passages individually before lighting torch

H. Light acetylene before opening oxygen torch valve

I. Never use oil or grease on regulators, torches, or fittings

(NOTE: Oil or grease and oxygen have a very great attraction for one another and will unite with explosive violence.)

J. Do not use oxygen as a substitute for compressed air

K. Use safety goggles, gloves, and protective clothing

(NOTE: Keep gloves, hands, and clothing free from oil and grease.)

L. Have CO_2 or dry powder type fire extinguisher available

M. Test connections for leaks with non-oil-based soapsuds, paint brush, and water

N. Avoid lighting torch or welding near combustible material

O. Never open the acetylene cylinder valve more than 1/2 to 3/4 turn

(CAUTION: Never open the cylinder more than 1 1/2 turns.)

P. Always operate torch in a well-ventilated place

Q. Never weld on containers that have been used for combustible materials

R. Avoid breathing toxic fumes when welding

Example: Galvanized metal

S. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

T. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on equipment

INFORMATION SHEET

U. Turn off acetylene torch valve first so flame will go out immediately

V. Never cut or weld near concrete

W. Always weld or cut at least five feet from cylinder

X. Always protect hoses from hot metal, rupture, or mechanical damage

Y. Always light torch with friction lighter

Z. Never leave a burning torch unattended

(NOTE: The instructor may want to add other safety rules.)

III. Oxyacetylene fusion welding equipment (Transparencies 1, 2, and 3)

A. Acetylene cylinder

B. Acetylene cylinder valve

C. Acetylene fitting (hex-grooved nut, left-hand threads)

D. Acetylene regulator

E. Oxygen cylinder

F. Oxygen cylinder valve

G. Oxygen fitting (right-hand threads)

H. Oxygen regulator

I. Oxygen torch valve

J. Torch body

K. Acetylene torch valve

L. Welding tip

M. Welding goggles

N. Welding gloves

O. Safety chain

P. Flint lighter

Q. Cylinder truck

R. Check valve

INFORMATION SHEET

IV. Factors that determine weld quality

  A. Proper flame adjustment

  B. Angle of tip

  C. Distance from work

  D. Speed of travel

  E. Movement of tip

V. Properties of a good weld

  A. Consistent width

  B. Straightness

  C. Slightly crowned

  D. Fused into base metal

  E. Clean appearance

VI. Factors that determine tip size

  A. Thickness of metal

  B. Size of welding rod

  (NOTE: Always use manufacturer's recommendation on tip size.)

VII. Factors that determine filler rod selection

  A. Rod with similar properties as base metal

  B. Thickness of metal

  (NOTE: A general rule is to use a rod with a diameter equal to the thickness of the base metal.)

VIII. Purpose of filler rod--To add strength to weld or joint

IX. Characteristics of oxyacetylene fusion welding flames (Transparency 4)

  A. Carburizing flame

    1. Contains an excess of acetylene

    (NOTE: An acetylene feather is visible on the inner cone.)

INFORMATION SHEET

2. Is the recommended flame for welding cast iron and aluminum and for hard surfacing
3. Introduces carbon into weld and causes hardening of the metal

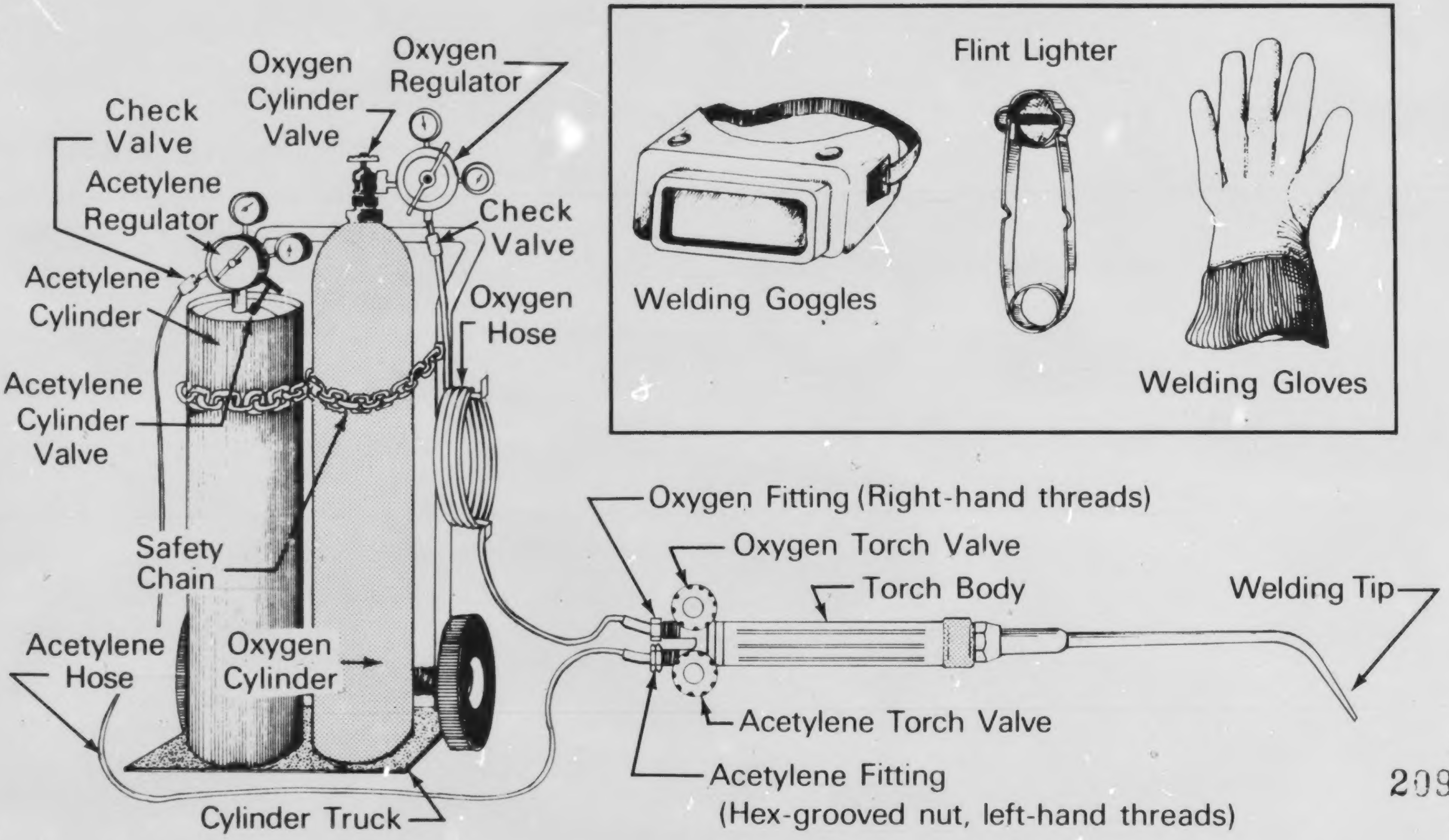
B. Oxidizing flame

1. Burns an excess of oxygen
2. Is identified by short inner cone
3. Oxidizes the metal, causing it to harden and become brittle
4. Is not recommended for welding of most metals
5. Is the hottest flame
6. Is recommended for brazing when slightly oxidized

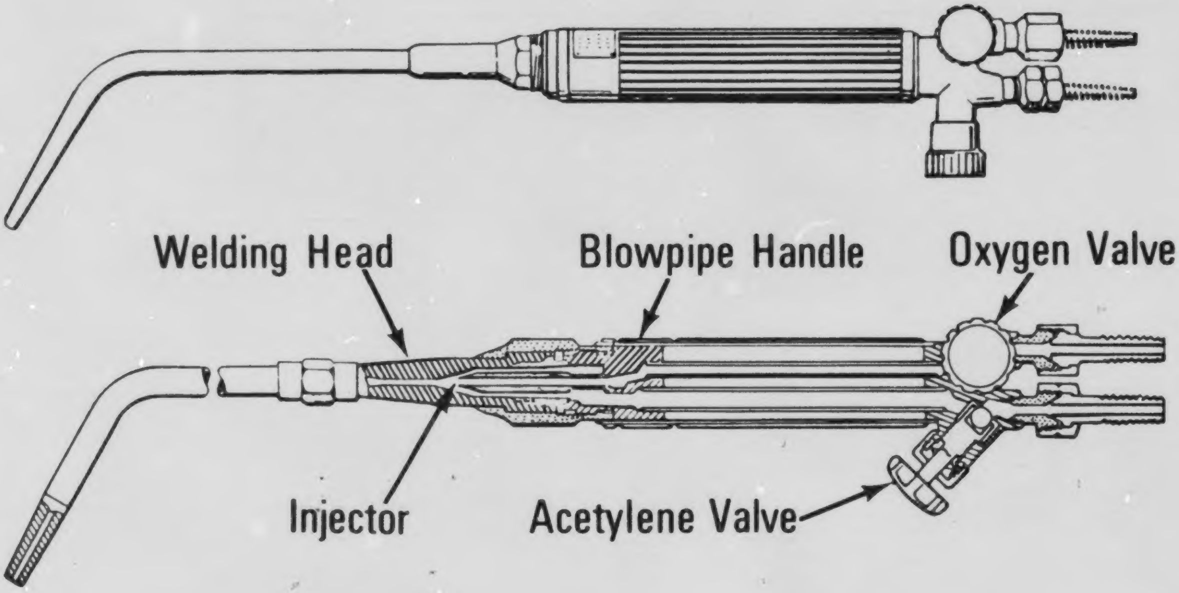
C. Neutral flame

1. Burns equal parts of oxygen and acetylene
2. Is identified by clear, well-defined white inner cone
3. Burns at a temperature of approximately 5950°F

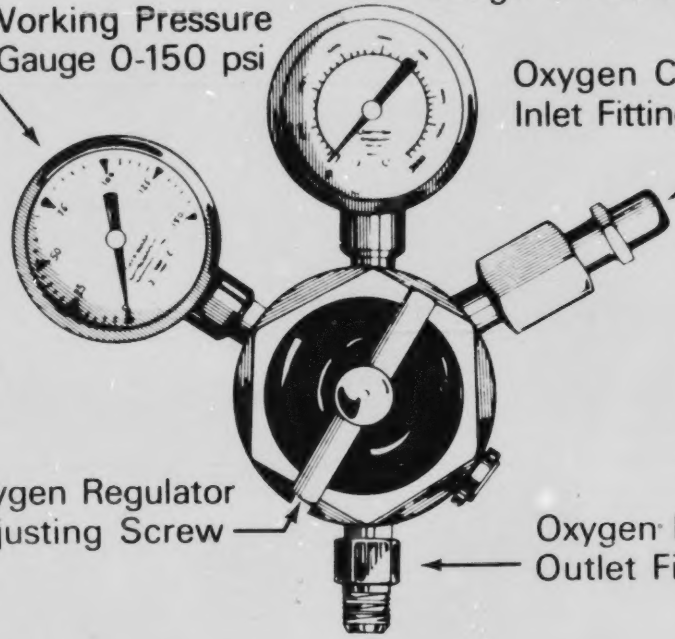
Oxyacetylene Fusion Welding Equipment


Flint Lighter
Welding Goggles
Welding Gloves
Oxygen Cylinder Valve
Oxygen Regulator
Check Valve
Acetylene Regulator
Check Valve
Acetylene Cylinder
Oxygen Hose
Acetylene Cylinder Valve
Safety Chain
Acetylene Hose
Oxygen Cylinder
Cylinder Truck
Oxygen Fitting (Right-hand threads)
Oxygen Torch Valve
Torch Body
Welding Tip
Acetylene Torch Valve
Acetylene Fitting
(Hex-grooved nut, left-hand threads)

Welding Torches


Welding Head
Blowpipe Handle
Oxygen Valve
Injector
Acetylene Valve

Welding Regulators



Cylinder Pressure Gauge 0-3000 psi

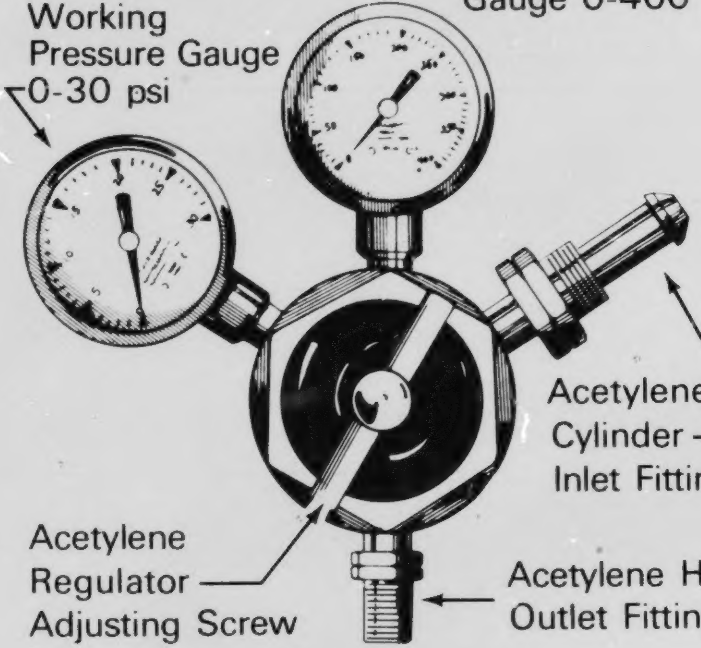
Working Pressure Gauge 0-150 psi

Oxygen Cylinder Inlet Fitting

Oxygen Regulator Adjusting Screw

Oxygen Hose Outlet Fitting

Oxygen Regulator



Cylinder Pressure Gauge 0-400 psi

Working Pressure Gauge 0-30 psi

Acetylene Cylinder Inlet Fitting

Acetylene Regulator Adjusting Screw

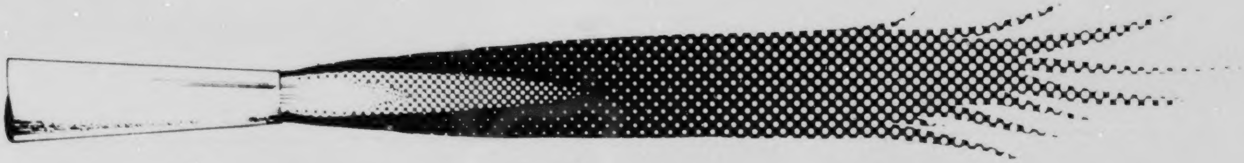
Acetylene Hose Outlet Fitting

Acetylene Regulator

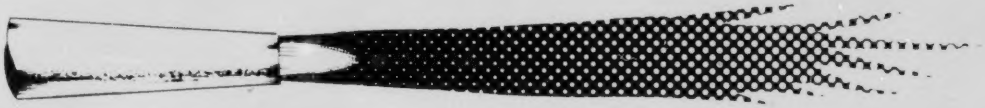
211

212

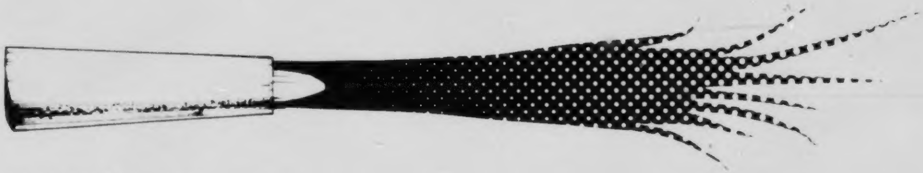
Oxyacetylene Fusion Welding Flames



Carburizing Flame



Neutral Flame



Oxidizing Flame

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #1--TURN ON, LIGHT, ADJUST, AND TURN OFF OXYACETYLENE WELDING EQUIPMENT

I. Tools and materials

  A. Oxygen cylinder

  B. Acetylene cylinder

  C. Hoses

  D. Oxygen and acetylene regulators

  E. Torch body and welding tips

  F. Cylinder holder and hose rack

  G. Flint lighter

  H. Welding goggles with #5 lens

  I. Gloves

  J. Coveralls or protective clothing

II. Procedure

  A. Check all cylinder, regulator, and torch valves to make sure they are turned off

  B. Open acetylene cylinder valve 1/2 to 3/4 of a turn

  (CAUTION: Never open the cylinder valve more than 1 1/2 turns because of the time involved in an emergency shut off.)

  C. Open acetylene valve on torch one turn to clear line

  D. Turn acetylene regulator pressure adjusting screw clockwise until desired working pressure is reached

  (NOTE: The working pressure is determined by the size of the tip which should be the same as the pounds of oxygen and acetylene.)

  E. Close acetylene valve on torch

  F. Open oxygen cylinder valve slowly all the way and tighten in open position

  G. Open oxygen torch valve one turn

JOB SHEET #1

H. Turn oxygen regulator pressure adjusting screw clockwise until desired pressure is reached

(NOTE: The working pressure is determined by the size of the tip.)

I. Close oxygen valve on torch

J. Open acetylene valve on torch 1/4 turn

K. Light the torch with flint lighter and adjust until smoke on flame clears

L. Open oxygen torch valve and adjust to a neutral flame with a tiny trace of feather on the inner cone

    1. To produce a carburizing flame--Reduce the supply of oxygen by slowly closing the oxygen torch valve until an excess acetylene feather is produced

    2. To produce an oxidizing flame--Increase the supply of oxygen by slowly opening the oxygen torch valve until a short, white inner cone is produced

M. Close acetylene torch valve

N. Close oxygen torch valve

O. Close acetylene cylinder valve

P. Close oxygen cylinder valve

Q. Open acetylene torch valve

(NOTE: When gauges reach 0, release acetylene regulator pressure adjusting screw and close torch valve.)

R. Open oxygen valve on torch

(NOTE: When gauges reach 0, release oxygen regulator pressure adjusting screw and close torch valve.)

(CAUTION: Do not open the acetylene and oxygen torch valves at the same time.)

S. Place torch and hoses on hanger or brackets

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #2--CONSTRUCT A CORNER WELD WITHOUT A FILLER ROD

I. Tools and materials

   A. Oxyacetylene welding unit

   B. Welding tip, #3 or according to manufacturer's recommendations

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 2 strips of 16 gauge, 1 1/4" x 6"

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

   D. Set working pressure at 3 lbs or according to manufacturer's recommendations

   E. Light torch and adjust to a neutral flame with very slight feather

   F. Tack weld metal in position

   G. Place inner cone about 1/16" to 1/8" from plate

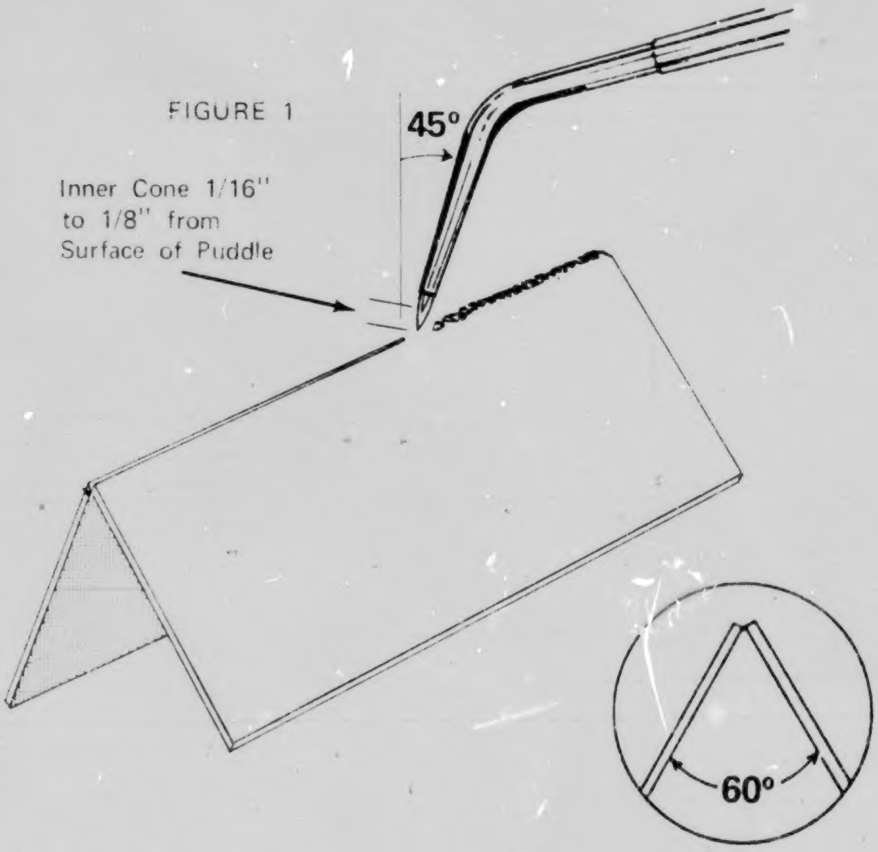
   H. Do not begin travel until you have established a molten puddle

   I. Begin welding at right end

JOB SHEET #2

J. Hold tip vertically at 45° angle from direction of travel (Figure 1)

FIGURE 1


45°
Inner Cone 1/16" to 1/8" from Surface of Puddle
60°

K. Slowly move flame down the joint, forming puddle as you travel from right to left

L. Examine welded joint for good bead characteristics and penetration

(NOTE: Repeat the above process until instructor gives permission to go on to next job.)

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #3--LAY BEADS ON GAUGE METAL WITHOUT FILLER ROD

I. Tools and materials

  A. Oxyacetylene welding unit

  B. Welding tip, #3 or according to manufacturer's recommendations

  C. Gloves

  D. Goggles

  E. Pliers

  F. Wire brush

  G. Flint lighter

  H. Fire brick

  I. Mild steel, 1 strip of 16 gauge, 1 1/4" x 6"

II. Procedure

  A. Prepare metal for welding

  B. Place metal in welding position

  C. Turn on oxyacetylene unit

  D. Set working pressure at 3 lbs or according to manufacturer's recommendations

  E. Light torch and adjust to a neutral flame

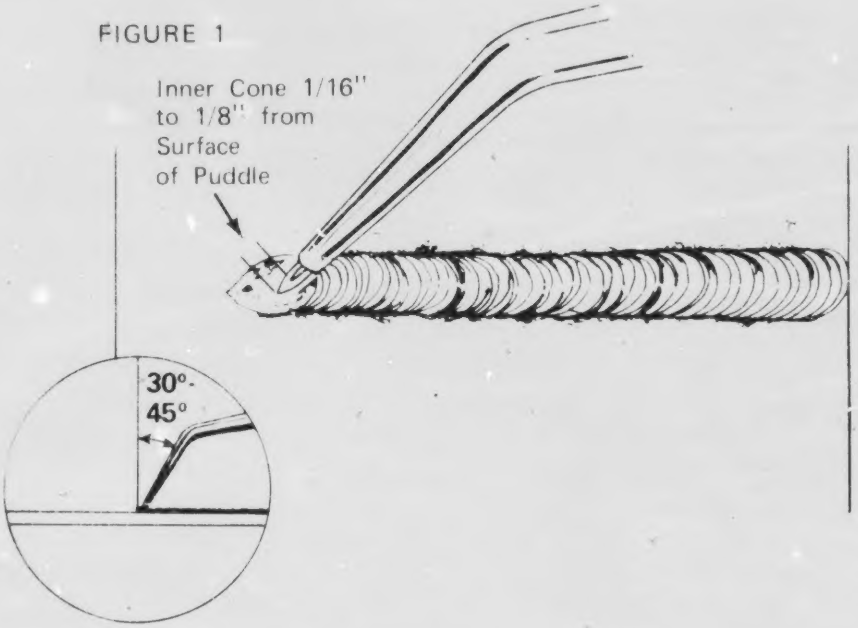
  F. Place inner cone about 1/16" to 1/8" from metal

  G. Do not begin travel until you have established a molten puddle

JOB SHEET #3

H. Hold torch 30° to 45° from center in direction of travel (Figure 1)

FIGURE 1


Inner Cone 1/16" to 1/8" from Surface of Puddle
30°-
45°

I. Slowly move the torch forward allowing the metal to melt

(NOTE: Repeat the above process until instructor gives permission to go on to next job.)

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #4--LAY BEADS ON GAUGE METAL WITH FILLER ROD

I. Tools and materials

   A. Oxyacetylene welding unit

   B. Welding tip, #3 or according to manufacturer's recommendations

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 1 strip of 16 gauge, 1 1/4" x 6"

   J. Mild steel filler rod (according to manufacturer's recommendations)

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

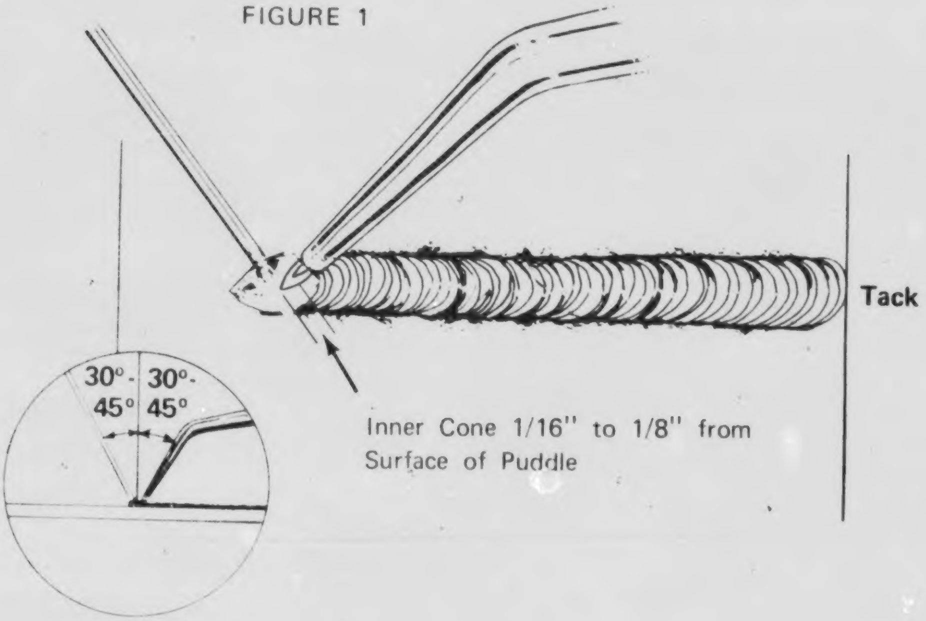
   D. Set working pressure at 3 lbs or according to manufacturer's recommendations

   E. Light torch and adjust to a neutral flame

JOB SHEET #4

F. Hold torch 30° to 45° from center (Figure 1)

FIGURE 1


Tack
30°-45°
30°-45°
Inner Cone 1/16" to 1/8" from Surface of Puddle

G. Place inner cone about 1/16" to 1/8" from surface of puddle

H. Do not begin travel until you have established a molten puddle

I. Add filler rod to front edge of puddle in front of torch

J. Move puddle forward with torch and allow puddle to form in base metal

K. Add rod to front edge of puddle and withdraw rod as you move puddle forward

L. Keep puddle the same size and shape for the entire length of the bead

(NOTE: Show bead to instructor when completed.)

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #5--WELD BUTT JOINTS WITH FILLER ROD

I. Tools and materials

   A. Oxyacetylene welding unit

   B. Welding tip, #3 or according to manufacturer's recommendations

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 2 strips of 16 gauge, 1 1/4" x 6"

   J. Mild steel filler rod (according to manufacturer's recommendations)

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position

   C. Turn on oxyacetylene unit

   D. Set working pressure at 3 lbs or according to manufacturer's recommendations

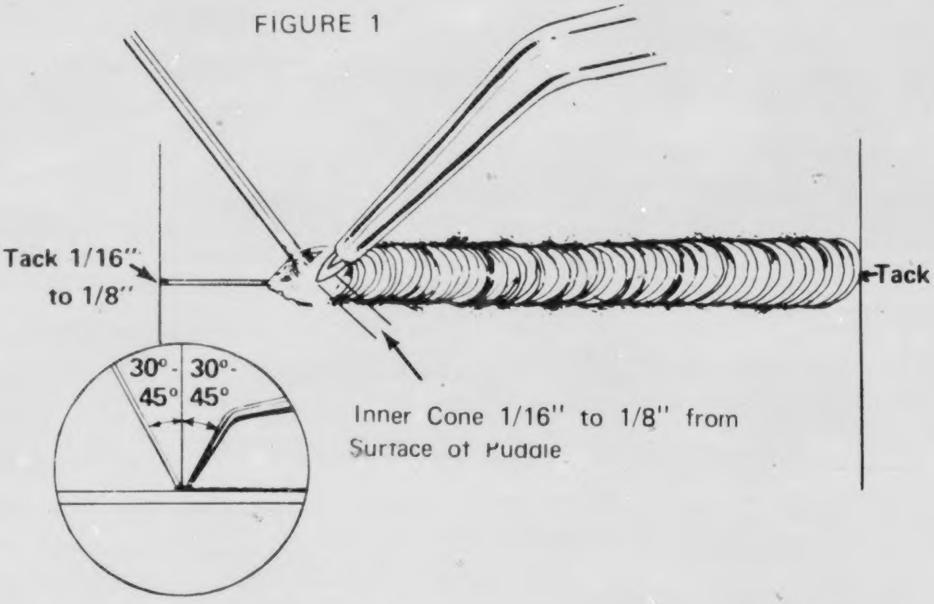
   E. Light torch and adjust to a neutral flame

   F. Tack weld metal together at both ends of joint

JOB SHEET #5

G. Hold torch 30° to 45° from center (Figure 1)

FIGURE 1


Tack 1/16" to 1/8"
Tack
30°-45°
30°-45°
Inner Cone 1/16" to 1/8" from Surface of Puddle

H. Do not begin travel until you have established a molten puddle

I. Place inner cone about 1/16" to 1/8" from surface of puddle

J. Add filler rod to front edge of puddle in front of torch

K. Move puddle forward with torch and allow puddle to form in base metal

L. Add rod to front edge of puddle and withdraw rod as you move puddle forward

M. Keep puddle the same size and shape for the entire length of the bead

(NOTE: Show bead to instructor when completed.)

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #6--WELD FLAT LAP WELD WITH FILLER ROD

I. Tools and materials

   A. Oxyacetylene welding unit

   B. Welding tip, #3 or according to manufacturer's recommendations

   C. Gloves

   D. Goggles

   E. Pliers

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 2 strips of 16 gauge, 1 1/4" x 6"

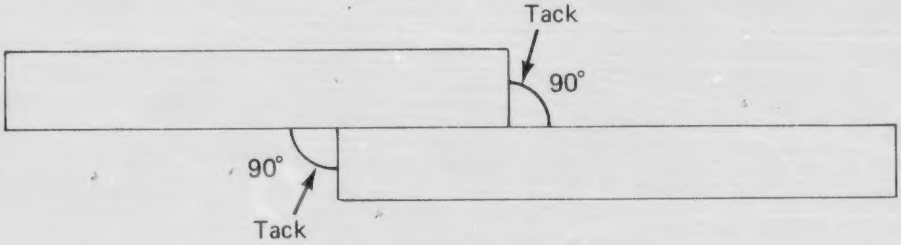
   J. Mild steel filler rod (according to manufacturer's recommendations)

II. Procedure

   A. Prepare metal for welding

   B. Place metal in welding position so that top strip lies flat on bottom strip (Figure 1)

FIGURE 1



   C. Turn on oxyacetylene unit

   D. Set working pressure at 3 lbs or according to manufacturer's recommendations

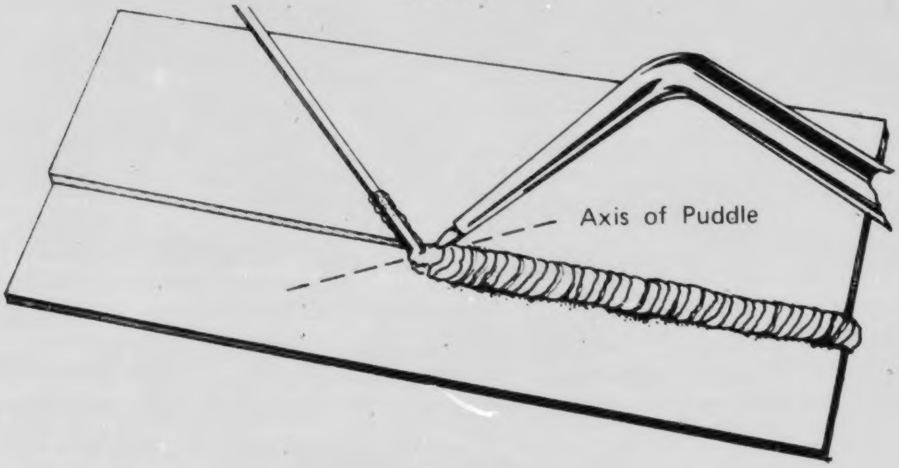
JOB SHEET #6

E. Light torch and adjust to a neutral flame with very slight feather

F. Tack weld metal in position (Figure 1)

G. Hold torch and filler rod as shown (Figures 2 and 3)

FIGURE 2



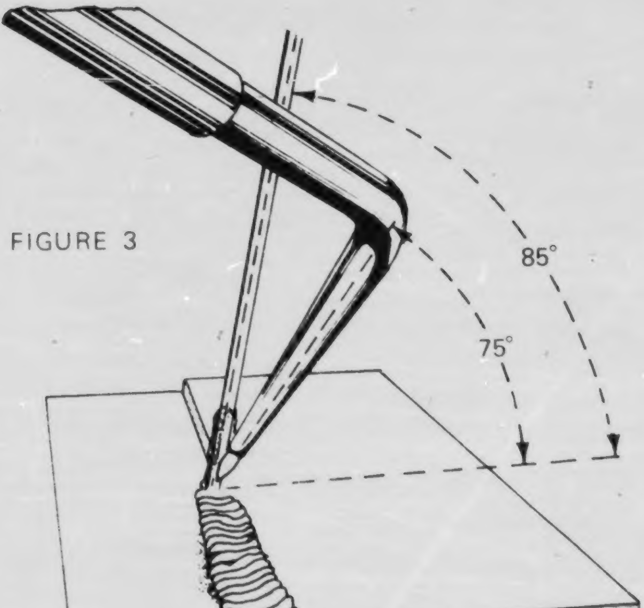


FIGURE 3

JOB SHEET #6

H. Do not begin travel until you have established a molten puddle

I. Place inner cone about 1/16" to 1/8" from surface of puddle

J. Add filler rod to front edge of puddle in front of torch

K. Move puddle forward with torch and allow puddle to form in base metal

L. Add rod to front edge of puddle and withdraw rod as you move puddle forward

M. Keep puddle the same size and shape for the entire length of the bead

(NOTE: Show bead to instructor when completed.)

OXYACETYLENE FUSION WELDING
UNIT IV

JOB SHEET #7--WELD TEE OR FILLET WELD WITH FILLER ROD

I. Tools and materials

  A. Oxyacetylene welding unit

  B. Welding tip (according to manufacturer's recommendations)

  C. Gloves

  D. Goggles

  E. Pliers

  F. Wire brush

  G. Flint lighter

  H. Fire brick

  I. Mild steel, 2 strips of 16 gauge, 1 1/4" x 6"

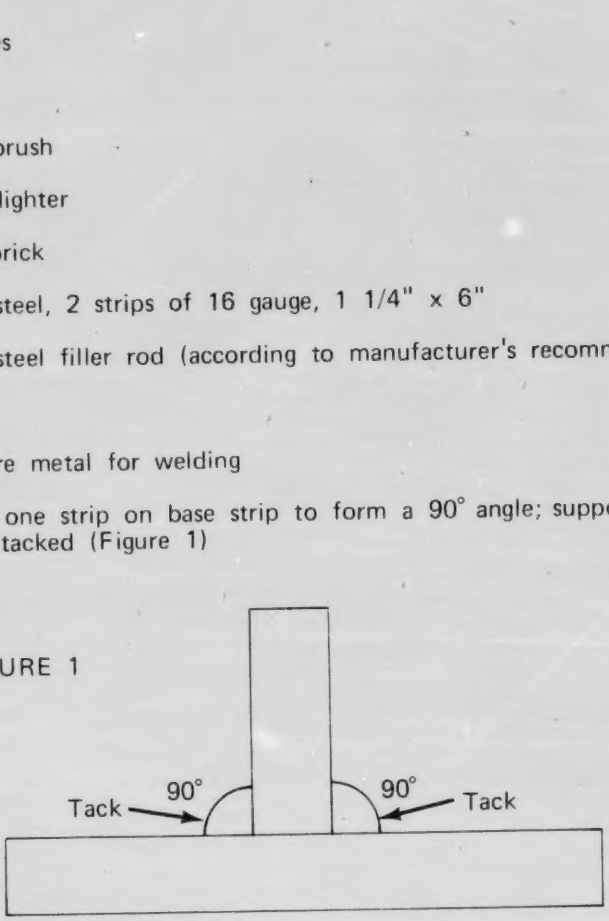
  J. Mild steel filler rod (according to manufacturer's recommendations)

II. Procedure

  A. Prepare metal for welding

  B. Place one strip on base strip to form a 90° angle; support vertical strip until tacked (Figure 1)

FIGURE 1



  C. Turn on oxyacetylene unit

  D. Set working pressure (according to manufacturer's recommendations)

  E. Light torch and adjust to a neutral flame

JOB SHEET #7

F. Tack weld metal (Figure 1)

G. Hold torch as indicated (Figures 2 and 3)

FIGURE 2

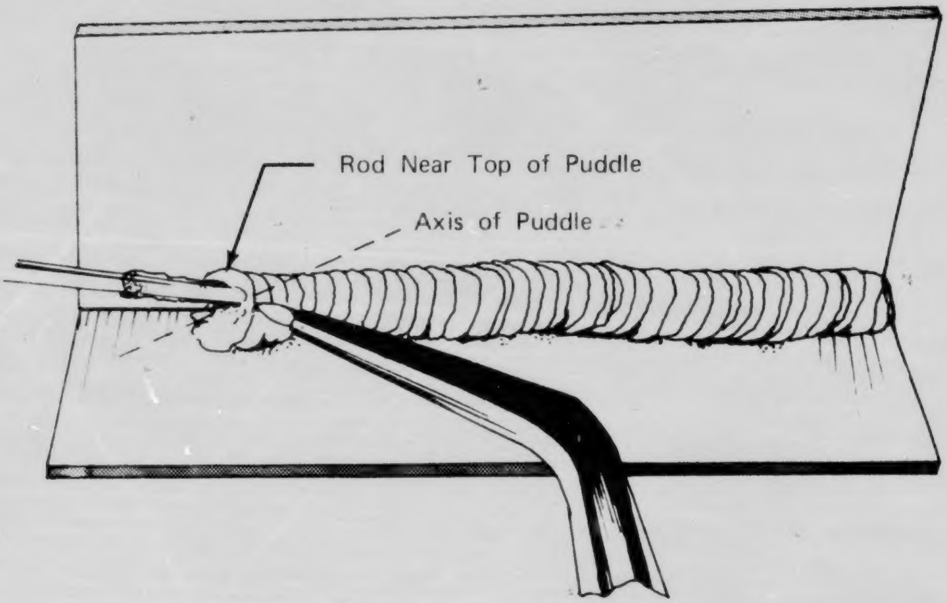
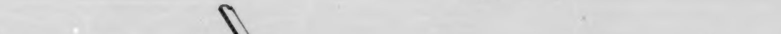

Rod Near Top of Puddle
Axis of Puddle

FIGURE 3



JOB SHEET #7

H. Do not begin travel until you have established a molten puddle

I. Place inner cone about 1/16" to 1/8" from surface of puddle

J. Add filler rod to front edge of puddle in front of torch

K. Move puddle forward with torch and allow puddle to form in base metal

L. Add rod to front edge of puddle and withdraw rod as you move puddle forward

M. Keep puddle the same size and shape for the entire length of the bead

(NOTE: Show bead to instructor when completed.)

OXYACETYLENE FUSION WELDING
UNIT IV

TEST

NAME ______________________________ SCORE ____________________

1. Match the terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. Metal to be welded

_____b. Fire inside the torch; indicated by a hissing or squealing sound

_____c. Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

_____d. Inner white part of a neutral flame

_____e. Distance from the original surface of the base metal to that point at which fusion ceases

_____f. Short weld used for temporarily holding metal in place

_____g. Mixture with metallic properties; composed of two or more elements of which at least one is a metal

_____h. Prevents the mixing of gases and removes hazard of explosion

_____i. Momentary burning back of the flame into the tip; flame goes out with a loud snap or pop

1. Tack weld
2. Flashback
3. Backfire
4. Inner cone
5. Alloy
6. Base metal
7. Penetration
8. Fusion welding
9. Check valve

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

3. Identify the parts of oxyacetylene fusion welding equipment illustrated below by writing the correct names in the blanks.

a. ____________

b. ____________

c. ____________

d. ____________

e. ____________

f. ____________

g. ____________

h. ____________

i. ____________

j. ____________

k. ____________

l. ____________

m. ____________

n. ____________

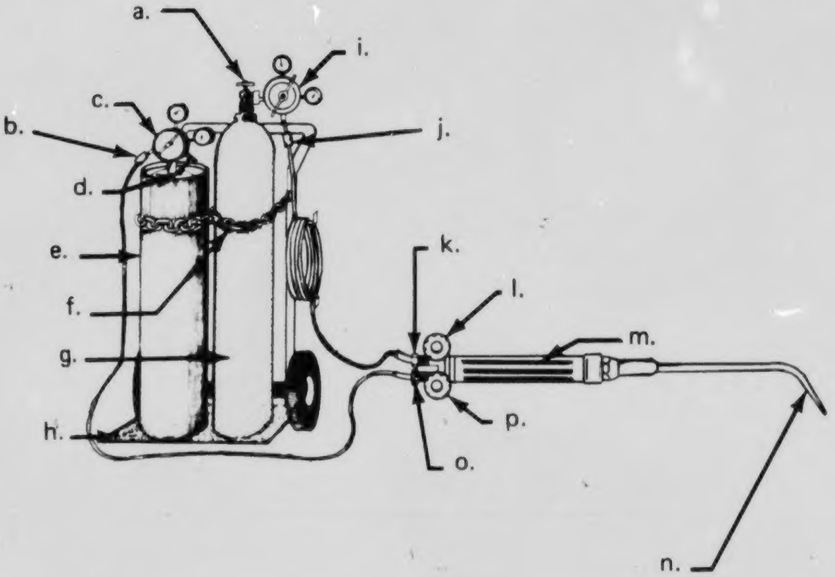
o. ____________

p. ____________

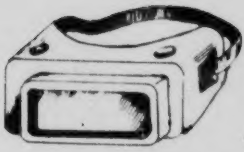
q. ____________

r. ____________

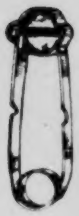
s. ____________


a.
i.
c.
b.
j.
d.
e.
k.
f.
l.
m.
g.
p.
h.
o.
n.

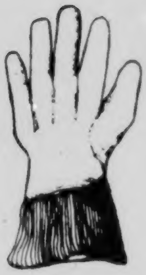
q.



r.



s.



4. Select from the list below factors that determine weld quality by placing an "X" in the appropriate blanks.

_____a. Proper flame adjustment

_____b. Angle of tip

_____c. Distance from work

_____d. Speed of travel

_____e. Movement of tip

_____f. Thickness of metal

_____g. Width of bead

5. List three properties of a good weld.

a. ______________________________

b. ______________________________

c. ______________________________

6. Select from the list below factors that determine tip size by placing an "X" in the appropriate blanks.

_____a. Size of welding rod

_____b. Temperature of metal

_____c. Thickness of metal

_____d. Distance to work

7. List the factors that determine filler rod selection.

a. ______________________________

b. ______________________________

8. State the purpose of a filler rod.

____

____

9. Classify the types of oxyacetylene fusion welding flames. Place a "C" in front of the characteristics for carburizing, an "O" in front for oxidizing, and an "N" in front for neutral. A blank may not have more than one answer.

_____a. Introduces carbon into weld and causes hardening of the metal

_____b. Burns an excess of oxygen

_____c. Is the recommended flame for welding cast iron and aluminum and for hard surfacing

_____d. Burns equal parts of oxygen and acetylene

_____e. Burns at a temperature of approximately 5950°F

_____f. Is the hottest flame

_____g. Is identified by short inner cone

_____h. Contains an excess of acetylene

_____i. Oxidizes the metal, causing it to harden and become brittle

_____j. Is recommended for brazing when slightly oxidized

_____k. Is identified by clear, well-defined white inner cone

_____l. Is not recommended for welding of most metals

10. Demonstrate the ability to:

a. Turn on, light, adjust, and turn off oxyacetylene welding equipment.

b. Construct a corner weld without filler rod.

c. Lay beads on gauge metal without filler rod.

d. Lay beads on gauge metal with filler rod.

e. Weld butt joints with filler rod.

f. Weld flat lap weld with filler rod.

g. Weld tee or fillet weld with filler rod.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE FUSION WELDING
UNIT IV

ANSWERS TO TEST

1. Match the terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

   6 a. Metal to be welded

   2 b. Fire inside the torch; indicated by a hissing or squealing sound

   8 c. Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   4 d. Inner white part of a neutral flame

   7 e. Distance from the original surface of the base metal to that point at which fusion ceases

   1 f. Short weld used for temporarily holding metal in place

   5 g. Mixture with metallic properties; composed of two or more elements of which at least one is a metal

   9 h. Prevents the mixing of gases and removes hazard of explosion

   3 i. Momentary burning back of the flame into the tip; flame goes out with a loud snap or pop

   1. Tack weld
   2. Flashback
   3. Backfire
   4. Inner cone
   5. Alloy
   6. Base metal
   7. Penetration
   8. Fusion welding
   9. Check valve

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

   (NOTE: Any ten of the following are acceptable.)

   a. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   b. Blow out cylinder valves in order to remove dust and dirt that may damage regulators

   c. Release pressure adjusting screw on regulator before opening cylinder valve to prevent damage to regulator and possible injury to operator

d. Stand to the side of regulator, keeping the cylinder valve between operator and regulator while opening cylinder valve

e. Open cylinder valve slowly

f. Do not use acetylene (in free state) at pressures higher than 15 psi

g. Clear oxygen and acetylene passages individually before lighting torch

h. Light acetylene before opening oxygen torch valve

i. Never use oil or grease on regulators, torches, or fittings

j. Do not use oxygen as a substitute for compressed air

k. Use safety goggles, gloves, and protective clothing

l. Have CO_2 or dry powder type fire extinguisher available

m. Test connections for leaks with non-oil-based soapsuds, paint brush, and water

n. Avoid lighting torch or welding near combustible material

o. Never open acetylene cylinder valve more than 1/2 to 3/4 turn

p. Always operate torch in a well-ventilated place

q. Never weld on containers that have been used for combustible materials

r. Avoid breathing toxic fumes when welding

s. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

t. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on equipment

u. Turn off acetylene torch valve first so flame will go out immediately

v. Never cut or weld near concrete

w. Always weld or cut at least five feet from cylinder

x. Always protect hoses from hot metal, rupture, or mechanical damage

y. Always light torch with friction lighter

z. Never leave a burning torch unattended

(NOTE: Instructor may want to add others.)

3. Identify the parts of oxyacetylene fusion welding equipment illustrated below by writing the correct names in the blanks.

a. Oxygen cylinder valve

b. Check valve

c. Acetylene regulator

d. Acetylene cylinder valve

e. Acetylene cylinder

f. Safety chain

g. Oxygen cylinder

h. Cylinder truck

i. Oxygen regulator

j. Check valve

k. Oxygen fitting (right-hand threads)

l. Oxygen torch valve

m. Torch body

n. Welding tip

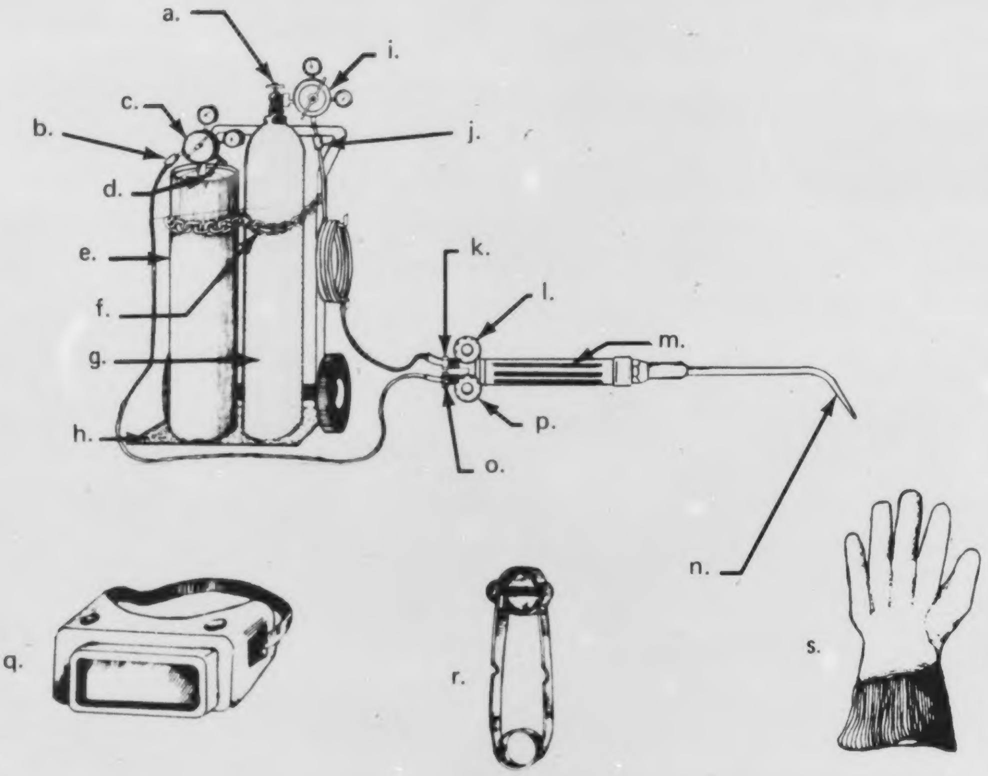
o. Acetylene fitting (hex-grooved nut, left-hand threads)

p. Acetylene torch valve

q. Welding goggles

r. Flint lighter

s. Welding gloves



4. Select from the list below factors that determine weld quality by placing an "X" in the appropriate blanks.

   __X__ a. Proper flame adjustment

   __X__ b. Angle of tip

   __X__ c. Distance from work

   __X__ d. Speed of travel

   __X__ e. Movement of tip

   _____ f. Thickness of metal

   _____ g. Width of bead

5. List three properties of a good weld.

   (NOTE: Any three of the following are acceptable.)

   a. Consistent width

   b. Straightness

   c. Slightly crowned

   d. Fused into base metal

   e. Clean appearance

6. Select from the list below factors that determine tip size by placing an "X" in the appropriate blanks.

   __X__ a. Size of welding rod

   _____ b. Temperature of metal

   __X__ c. Thickness of metal

   _____ d. Distance to work

7. List the factors that determine filler rod selection.

   a. Rod with similar properties as base metal

   b. Thickness of metal

8. State the purpose of a filler rod.

   To add strength to weld or joint

9. Classify the types of oxyacetylene fusion welding flames. Place a "C" in front of the characteristics for carburizing, an "O" in front for oxidizing, and an "N" in front for neutral. A blank may not have more than one answer.

C a. Introduces carbon into weld and causes hardening of the metal

O b. Burns an excess of oxygen

C c. Is the recommended flame for welding cast iron and aluminum and for hard surfacing

N d. Burns equal parts of oxygen and acetylene

N e. Burns at a temperature of approximately 5950°F

O f. Is the hottest flame

O g. Is identified by short inner cone

C h. Contains an excess of acetylene

O i. Oxidizes the metal, causing it to harden and become brittle

O j. Is recommended for brazing when slightly oxidized

N k. Is identified by clear, well-defined white inner cone

O l. Is not recommended for welding of most metals

10. Demonstrate the ability to:

a. Turn on, light, adjust, and turn off oxyacetylene welding equipment.

b. Construct a corner weld without filler rod.

c. Lay beads on gauge metal without filler rod.

d. Lay beads on gauge metal with filler rod.

e. Weld butt joints with filler rod.

f. Weld flat lap weld with filler rod.

g. Weld tee or fillet weld with filler rod.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

OXYACETYLENE BRAZE WELDING
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the differences between braze welding and fusion welding and list advantages and disadvantages of braze welding. The student should also be able to describe the reactions when adding bronze to base metal that is too hot, too cold, or correct. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene braze welding to the correct definitions.
2. List advantages and disadvantages of braze welding.
3. Discuss in writing the importance of having a chemically clean metal surface in braze welding.
4. Select from a list methods for removing oxides from a clean metal surface.
5. Describe the differences between braze welding and fusion welding.
6. List the purposes for using flux.
7. Describe the reactions of molten bronze when the temperature of the base metal is too hot, too cold, and correct.
8. Demonstrate the ability to:
    a. Braze weld a square groove butt joint.
    b. Braze weld a lap joint.
    c. Braze weld a tee or fillet joint.

OXYACETYLENE BRAZE WELDING
UNIT V

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparency.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   (NOTE: The instructor may want to secure the film on braze welding from a local welding supplier or the Curriculum and Instructional Materials Center to show to the class.)

   G. Give test.

II. Unit references:

   A. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division, 1960.

   B. Althouse, Andrew D.; Turnquist, Carl H.; and Bowditch, William A. *Modern Welding.* Homewood, Illinois: Goodheart-Willcox Co., Inc., 1965.

   C. Giachino, J.W.; Weeks, William; and Brune, Elmer. *Welding Skills and Practices.* Chicago: American Technical Society, 1967.

III. Film--"Oxyacetylene Welding: Torch Techniques." BFA Educational Media; 2211 Michigan Avenue; Santa Monica, California 90404.

(NOTE: Only Oklahoma teachers may order films from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1515 West Sixth, Stillwater, Oklahoma 74074. Out-of-state teachers may purchase and/or rent materials from the address listed.)

OXYACETYLENE BRAZE WELDING
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Braze welding--Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted (Transparency 1)

B. Malleability--Property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

C. Ductile--Capable of being drawn or stretched out

D. Tinning operation--Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

(NOTE: It is this flow of the thin film of bronze which is known as *tinning.*)

E. Flux--Chemical used to clean metals and to promote fusion during the welding process

II. Advantages and disadvantages of braze welding

A. Advantages

1. Provides less chance of destroying main characteristics of base metal since it is not heated to a molten condition
2. Consumes less gas
3. Can be used on thin metals
4. Can be used on malleable castings
5. Increases speed of joining metals
6. May be used to join different kinds of metals

B. Disadvantages

1. Cannot be used on metal where stress is a factor
2. Bronze rod is expensive to use

INFORMATION SHEET

3. Not recommended for parts which are raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

   (NOTE: The melting point is 1125-1760°F.)

4. Bronze will lose its strength at temperatures above 500°F

5. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

III. Importance of having a chemically clean metal surface in braze welding

   A. Ensures that the molten bronze will stick to the base metal

   B. Has a stronger bond on base metal

   C. Allows bronze to flow smoothly and evenly over entire weld area

IV. Methods for removing oxides from a clean metal surface

   A. Mechanical means

      1. Wire brush

      2. Grinder

   B. Chemical means--Flux

   (NOTE: Both methods should be used to completely remove the oxides.)

V. Differences between braze welding and fusion welding

   A Braze welding

      1. Base metal is not melted

         (NOTE: Base metal is heated only to a dull red color.)

      2. Alloy rod is used to lay a thin coat of bronze along the seam

   B. Fusion welding

      1. Base metal is melted and joined

      2. Rod with similar characteristics of base metal must be used

INFORMATION SHEET

VI. Purposes for using flux

A. Clean the base metal chemically

B. Prevent oxidation of filler metal

C. Float and remove oxides already present

D. Increase flow of filler metal

E. Increase the ability of filler metal to adhere to the base metal

F. Bring the filler metal into immediate contact with metals being joined

G. Permit the filler metal to penetrate the pores of the base metal

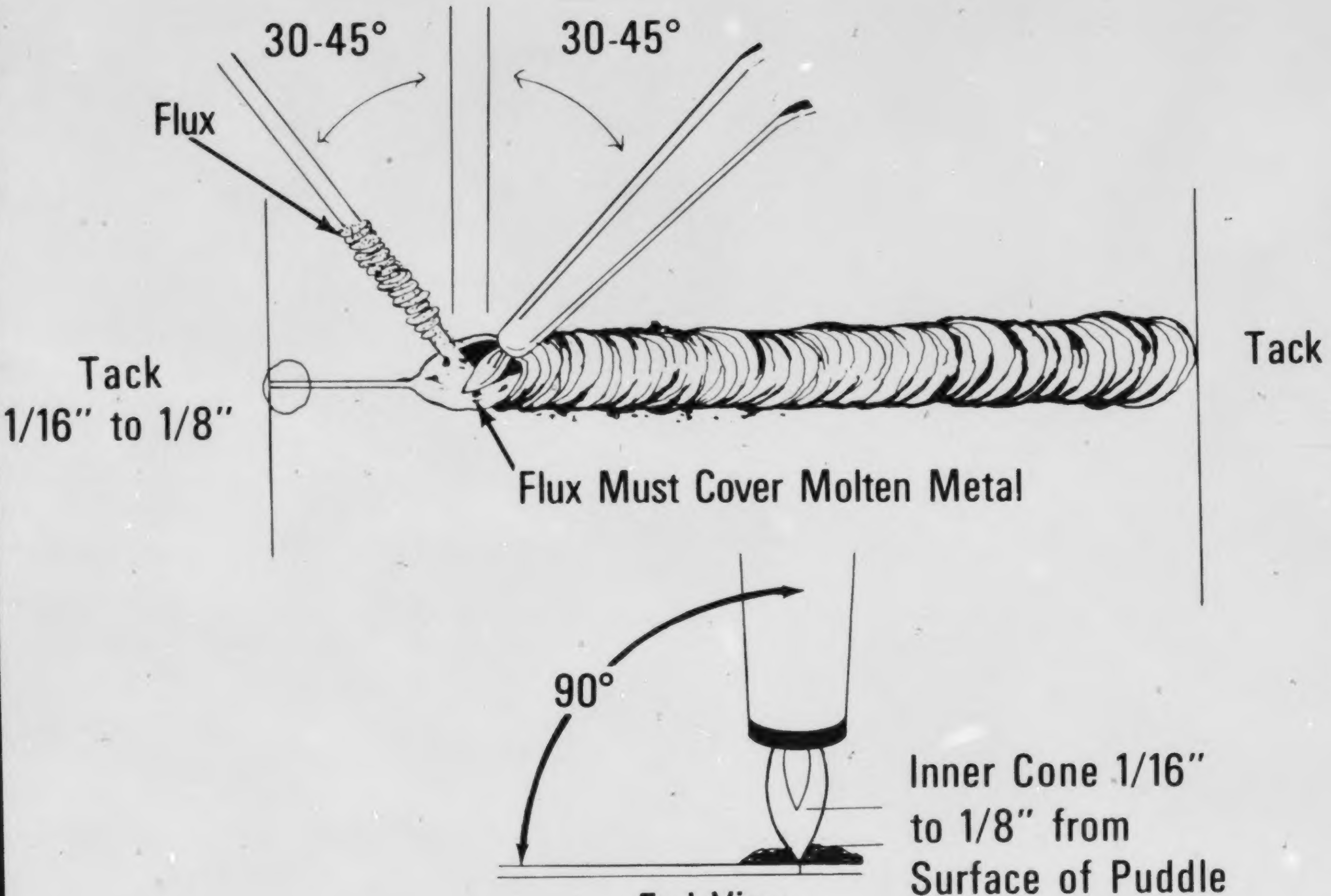
VII. Reaction of molten bronze at different temperatures

A. Too hot--Molten bronze will tend to boil, form little balls, and turn light blue with a hissing sound

B. Too cool--Molten bronze will form into drops rather than flowing evenly over the surface

C. Correct--Molten bronze will spread evenly and flow over a considerable area

Braze Welding A Butt Joint


30-45°
30-45°
Flux
Tack
1/16" to 1/8"
Tack
Flux Must Cover Molten Metal
90°
Inner Cone 1/16" to 1/8" from Surface of Puddle
End View

OXYACETYLENE BRAZE WELDING
UNIT V

JOB SHEET #1--BRAZE WELD A SQUARE GROOVE BUTT JOINT

I. Tools and equipment

- A. Oxyacetylene welding unit
- B. Gloves
- C. Safety glasses
- D. Goggles
- E. Welding tip, #5 or according to manufacturer's recommendations
- F. Wire brush
- G. Flint lighter
- H. Fire brick
- I. Mild steel, 2 strips, 1/8" thick, 1 1/4" x 6"
- J. Bronze filler rod (use according to manufacturer's recommendations)
- K. Welding flux

II. Procedure

- A. Clean metal
- B. Place metal in brazing position, 1/16" to 1/8" apart
- C. Turn on oxyacetylene unit
- D. Adjust working pressure of oxygen and acetylene to five pounds

  (NOTE: Use manufacturer's recommendations.)
- E. Place metal on fire brick

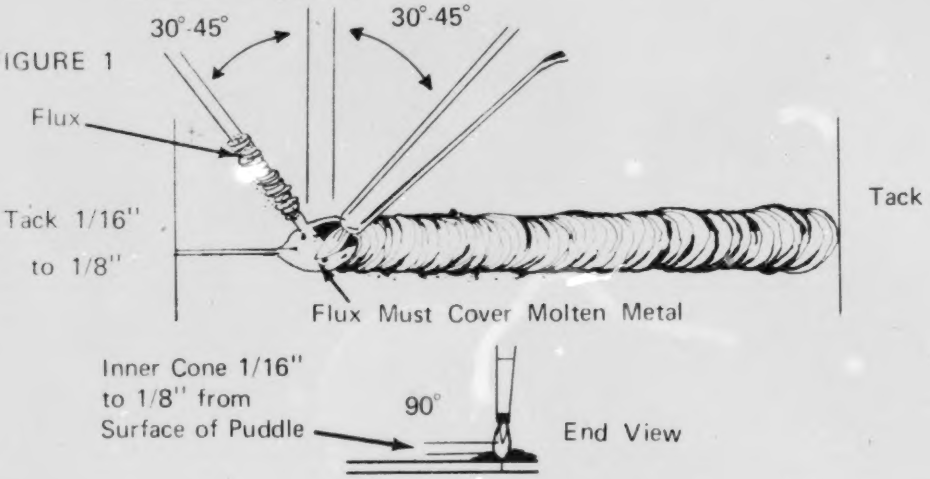
  (NOTE: Do not lay metal flat on brick. Arrange metal so a small space will be between the base metal and the fire brick.)
- F. Light and adjust torch to a neutral or slightly oxidizing flame
- G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod
- H. Tack metal in place using braze filler metal

JOB SHEET #1

I. Heat the surface of the weld area slightly

J. Hold torch 30° to 45° vertically; hold filler rod at same angle in opposite direction (Figure 1)

FIGURE 1


30°-45°
30°-45°
Flux
Tack 1/16" to 1/8"
Tack
Flux Must Cover Molten Metal
Inner Cone 1/16" to 1/8" from Surface of Puddle
90°
End View

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire seam when a cherry red color occurs

L. Start depositing the proper size bead when the base metal is tinned sufficiently

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil.)

M. Complete the weld and practice doing other welds

N. Inspect weld

(NOTE: Show weld to instructor.)

OXYACETYLENE BRAZE WELDING
UNIT V

JOB SHEET #2--BRAZE WELD A LAP JOINT

I. Tools and equipment

   A. Oxyacetylene welding unit

   B. Gloves

   C. Safety glasses

   D. Goggles

   E. Welding tip, #5 or according to manufacturer's recommendations

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 2 strips, 1/8" thick, 1 1/4" x 6"

   J. Bronze filler rod

   K. Welding flux

II. Procedure

   A. Clean metal

   B. Place metal in brazing position with each strip overlapping the other a 1/2"

   C. Turn on oxyacetylene unit

   D. Adjust working pressure of oxygen and acetylene to five pounds

   (NOTE: Use manufacturer's recommendations.)

   E. Place metal on fire brick

   F. Light and adjust torch to a neutral or slightly oxidizing flame

   G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod

JOB SHEET #2

H. Tack metal in place using braze filler metal

I. Preheat joint at right end and weld to the left

J. Hold torch and filler rod as shown in Figures 1 and 2

FIGURE 1

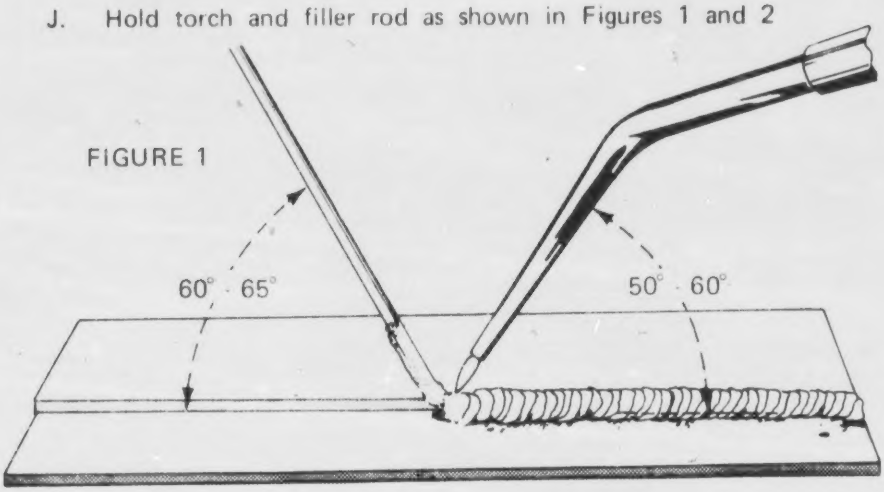
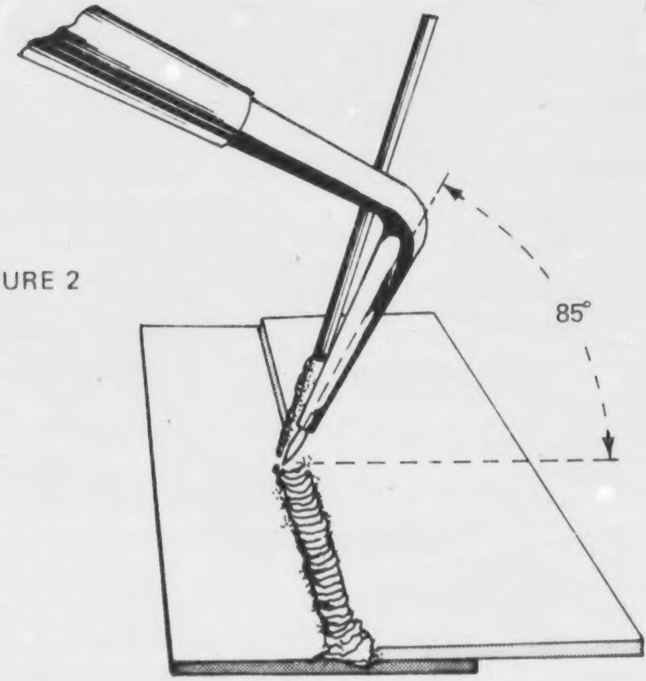


FIGURE 2



JOB SHEET #2

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire width of seam when a cherry red color occurs

L. Start depositing the proper size bead when the base metal is tinned sufficiently

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil. Show weld to instructor when completed.)

OXYACETYLENE BRAZE WELDING
UNIT V

JOB SHEET #3--BRAZE WELD A TEE OR FILLET JOINT

I. Tools and equipment

   A. Oxyacetylene welding unit

   B. Gloves

   C. Safety glasses

   D. Goggles

   E. Welding tip, #5 or according to manufacturer's recommendations

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Mild steel, 2 strips, 1/8" thick, 1 1/4" x 6"

   J. Bronze filler rod

   K. Welding flux

II. Procedure

   A. Clean metal

   B. Place one strip on base strip to form a 90° angle; support vertical strip until tacked

   C. Turn on oxyacetylene unit

   D. Adjust working pressure of oxygen and acetylene to five pounds

   (NOTE: Use manufacturer's recommendations.)

   E. Place metal on fire brick

   F. Light and adjust torch to a neutral or slightly oxidizing flame

   G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod

JOB SHEET #3

H. Tack metal in place using braze filler rod

I. Preheat the right side and weld to left

J. Hold torch and filler rod as shown in Figures 1 and 2

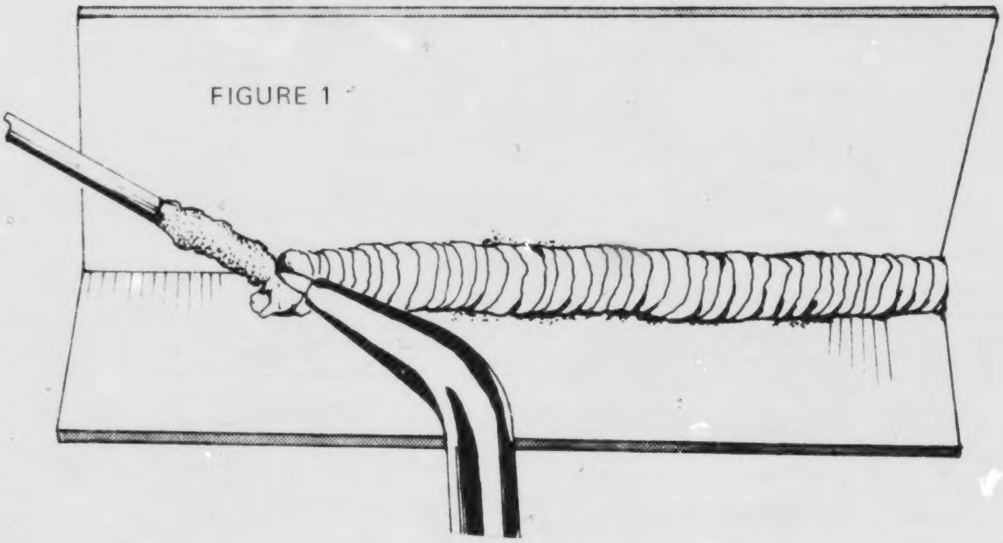


FIGURE 1

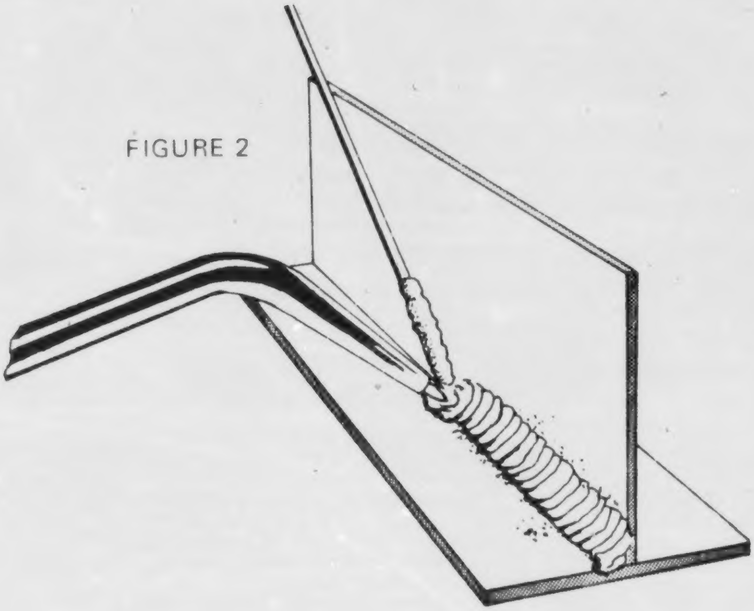


FIGURE 2

JOB SHEET #3

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire seam when a cherry red color occurs

L. Start depositing the proper size bead when the base metal is tinned sufficiently

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil. Show weld to instructor when completed.)

OXYACETYLENE BRAZE WELDING
UNIT V

TEST

NAME ______________________________ SCORE ____________________

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

______a. Capable of being drawn or stretched out	1. Flux
______b. Chemical used to clean metals and to promote fusion during the welding process	2. Braze welding
	3. Malleability
______c. Property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness	4. Tinning operation
	5. Ductile
______d. Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted	
______e. Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)	

2. List three advantages and three disadvantages of braze welding.

a. Advantages

1) ____

2) ____

3) ____

b. Disadvantages

1) ____

2) ____

3) ____

3. Discuss in writing the importance of having a chemically clean metal surface in braze welding.

____

____

____

____

4. Select from the list below methods for removing oxides from a clean metal surface by placing an "X" in the correct blanks.

_____a. Wire brush

_____b. Hammer

_____c. Acid

_____d. Grinder

_____e. Flux

_____f. Water

5. Describe the differences between braze welding and fusion welding.

____

____

____

____

____

____

____

____

____

6. List five purposes for using flux.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

7. Describe the reactions of molten bronze at the temperatures listed below.

   a. Too hot

   ____

   ____

   b. Too cool

   ____

   ____

   c. Correct

   ____

   ____

8. Demonstrate the ability to:

   a. Braze weld a square groove butt joint.

   b. Braze weld a lap joint.

   c. Braze weld a tee or fillet joint.

   (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE BRAZE WELDING
UNIT V

ANSWERS TO TEST

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

__5__ a. Capable of being drawn or stretched out

__1__ b. Chemical used to clean metals and to promote fusion during the welding process

__3__ c. Property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

__2__ d. Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted

__4__ e. Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

1. Flux
2. Braze welding
3. Malleability
4. Tinning operation
5. Ductile

2. List three advantages and three disadvantages of braze welding.

(NOTE: Any three of the following from each group are acceptable.)

a. Advantages

1) Provides less chance of destroying main characteristics of base metal since it is not heated to a molten condition

2) Consumes less gas

3) Can be used on thin metals

4) Can be used on malleable castings

5) Increases speed of joining metals

6) May be used to join different kinds of metals

b. Disadvantages

1) Cannot be used on metal where stress is a factor

2) Bronze rod is expensive to use

3) Not recommended for parts which are raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

4) Bronze will lose its strength at temperatures above 500°F

5) Bronze may have corrosion-resistant properties which differ from those of the base metal being used

3. Discuss in writing the importance of having a chemically clean metal surface in braze welding.

a. Ensures that the molten bronze will stick to the base metal

b. Has a stronger bond on base metal

c. Allows bronze to flow smoothly and evenly over entire weld area

4. Select from the list below methods for removing oxides from a clean metal surface by placing an "X" in the correct blanks.

__X__ a. Wire brush

_____ b. Hammer

_____ c. Acid

__X__ d. Grinder

__X__ e. Flux

_____ f. Water

5. Describe the differences between braze welding and fusion welding.

a. Braze welding

1) Base metal is not melted

2) Alloy rod is used to lay a thin coat of bronze along the seam

b. Fusion welding

  1) Base metal is melted and joined

  2) Rod with similar characteristics of base metal must be used

6. List five purposes for using flux.

(NOTE: Any five of the following are acceptable.)

a. Clean the base metal chemically

b. Prevent oxidation of filler metal

c. Float and remove oxides already present

d. Increase flow of filler metal

e. Increase ability of filler metal to adhere to the base metal

f. Bring the filler metal into immediate contact with metals being joined

g. Permit the filler metal to penetrate the pores of the base metal

7. Describe the reactions of molten bronze at the temperatures listed below.

a. Too hot--Molten bronze will tend to boil, form little balls, and turn light blue with a hissing sound

b. Too cool--Molten bronze will form into drops rather than flowing evenly over the surface

c. Correct--Molten bronze will spread evenly and flow over a considerable area

8. Demonstrate the ability to:

a. Braze weld a square groove butt joint.

b. Braze weld a lap joint.

c. Braze weld a tee or fillet joint.

(NOTE: The performance skills should be evaluated to the satisfaction of the instructor.

PLUMBING AND PIPE FITTING
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify common pipe fittings and types of valves. The student should also be able to demonstrate proper procedures for fitting various kinds of pipe or tubing. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with plumbing to the correct definitions.
2. Match the various kinds of pipe to their uses.
3. Identify common pipe fittings and types of valves.
4. Select from a list reasons for using pipe joint compound.
5. Identify tools used in plumbing.
6. List reasons for using cutting oil.
7. Select from a list common sizes of pipe and copper tubing used in plumbing.
8. Describe how the pipe size is determined in relationship to the copper tubing.
9. Discuss the differences between pipe, bolt, and copper fitting threads.
10. List the kinds of pipe thread sealing compounds.
11. Demonstrate the ability to:
    a. Cut pipe.
    b. Ream pipe.
    c. Thread pipe.
    d. Join or fit plastic pipe.
    e. Sweat a copper joint.
    f. Cut and flare copper tubing.

PLUMBING AND PIPE FITTING
UNIT VI

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined on the job sheets.

   G. Give test.

II. Unit references:

   A. Phipps, Lloyd; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook.* Danville, Illinois: Interstate Printers and Publishers.

   B. Jones, M. M. *Shopwork on the Farm.* New York: McGraw-Hill Book Company.

   C. *General Shop Guide for Vo-Ag Students.* Montgomery: Alabama State Department of Education, Vocational Division, Agricultural Education Service.

   D. *Handy Man's Plumbing and Heating Guide.* New York: Arco Publishing Company, Inc., 1973.

PLUMBING AND PIPE FITTING
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Plumbing--Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste

B. Soil pipe--Any pipe that receives the discharge of waste water from house fixtures

C. Fitting--Piece used to join pipe, to provide opening in pipe, and to change the direction of pipe

D. Trap--Water-sealed bend or chamber in a waste pipe

E. House drain--Pipe which carries all the sewage from the house

F. Stack--Soil, waste, or ventilating pipe

G. Fixture--Appliance connected to the plumbing

H. Septic tank--Tank which receives all the sewage piped into it and allows the process of sewage treatment to take place

I. PVC--Polyvinyl chloride

J. Lateral pipe--Pipe which drains the liquid from the septic tank to the soil

II. Kinds of pipe and their uses

A. Black--Used for natural and LP gas, oil, and air lines

B. Galvanized--Used for water lines

C. Copper tubing--Used for water, refrigeration, and waste systems

D. Cast iron--Used in sewage systems

E. Brass or lead--Used for traps and drains

F. Plastic--Used in water systems

G. PVC--Plastic pipe used in water or sewage systems, air lines, and natural gas lines

(NOTE: There is a type of PVC for cold temperature lines and one for hot.)

H. Soil--Used in sewage system; generally a cast iron pipe

INFORMATION SHEET

III. Common pipe fittings and types of valves (Transparencies 1 and 2)
  A. Bushing
  B. Cap
  C. Plug
  D. 45° elbow
  E. 90° elbow
  F. Straight cross
  G. T
  H. Union
  I. Coupling
  J. 90° street elbow
  K. Y
  L. Floor flange
  M. Bell reducer
  N. Nipples
  O. Globe valve
  P. Gate valve
  Q. Gas stop

IV. Reasons for using pipe joint compound
  A. Insures tight joints
  B. Prevents threads from rusting

V. Tools used in plumbing (Transparencies 3 and 4)
  A. Flaring tool
  B. Burr reamer
  C. Small ratchet threader

INFORMATION SHEET

   D. Pipe wrench
   E. Bench yoke vise
   F. Chain vise
   G. Pipe cutter
   H. Spiral ratchet pipe reamer
   I. Die
   J. Tapered triangular file
   K. Tubing cutter
   L. Hacksaw

VI. Reasons for using cutting oil
   A. Allows tools to cut smoother
   B. Permits tools to cut easier
   C. Lengthens lifetime of tools
   D. Removes burrs and cuttings from dies

VII. Common sizes of pipe and copper tubing used in plumbing
   A. Pipe
      1. 1/4"
      2. 1/2"
      3. 3/4"
      4. 1"
      5. 1 1/4"
   B. Copper tubing
      1. 3/8"
      2. 7/16"
      3. 1/2"
      4. 3/16"
      5. 5/8"

INFORMATION SHEET

VIII. How pipe size is determined in relationship to copper tubing

- A. Pipe size determined by inside diameter
- B. Tubing size determined by outside diameter
- C. Pipe wall generally thicker

IX. Differences between pipe, bolt, and copper fitting threads (Transparency 5)

- A. Pipe
  1. Tapers 1/32" per inch in length

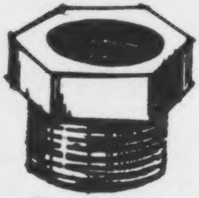
     (NOTE: This insures a tight fit.)
  2. Has standard threads
- B. Bolt
  1. Straight
  2. National coarse
  3. National fine
- C. Copper fitting--National fine threads

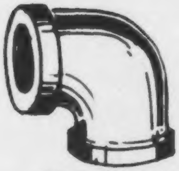
  (NOTE: National fine threads are used to provide more strength to insure a tight joint.)

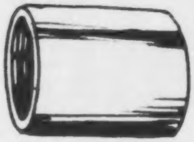
X. Kinds of pipe thread sealing compounds

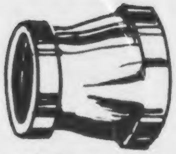
- A. White lead
- B. Red lead
- C. Oil and graphite
- D. Teflon tape

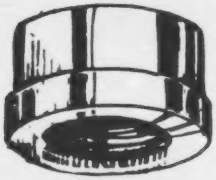
Pipe Fittings

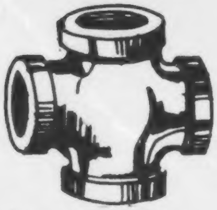

Bushing

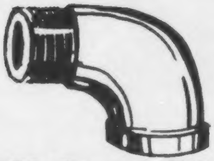

90° Elbow

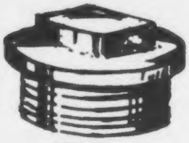

Coupling

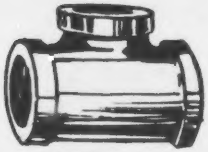

Bell Reducer


Cap


Straight Cross


90° Street Elbow


Plug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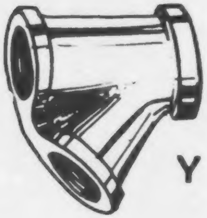
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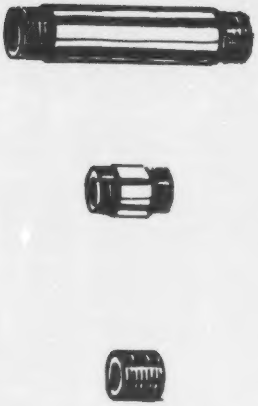
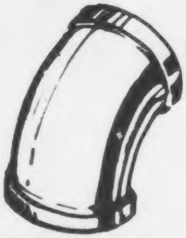
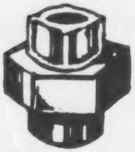
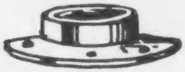
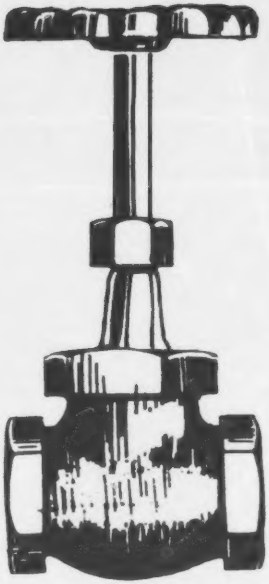

Nipples


45° Elbow

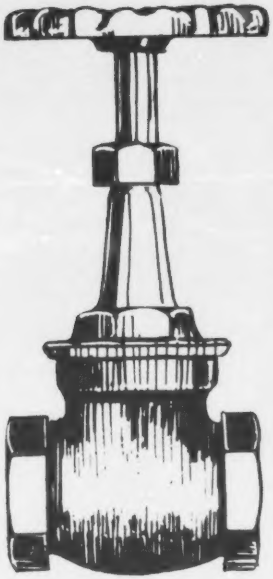

Union


Floor Flange

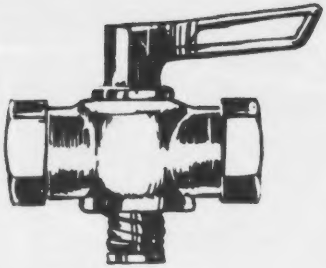
Types of Valves



Globe Valve

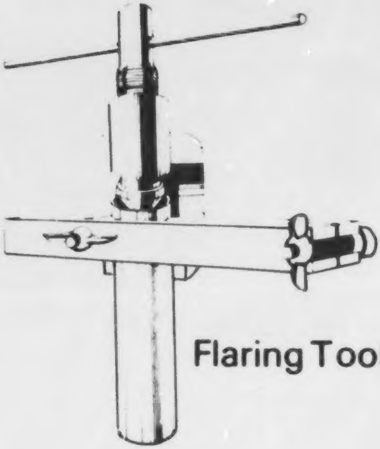


Gate Valve

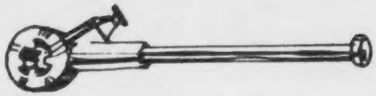


Gas Stop

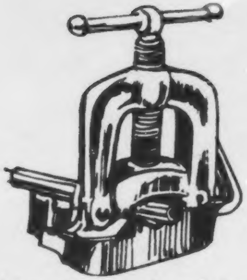
Plumbing Tools



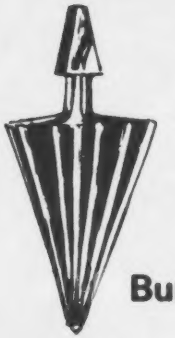
Flaring Tool



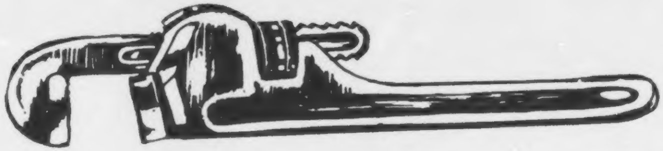
Small Ratchet Threader



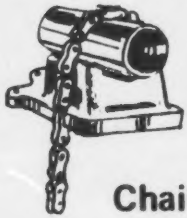
Bench Yoke Vise



Burr Reamer



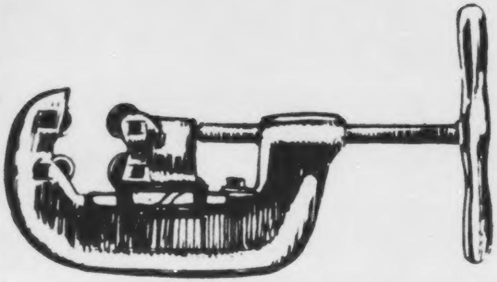
Pipe Wrench



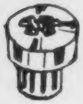
Chain Vise

Plumbing Tools

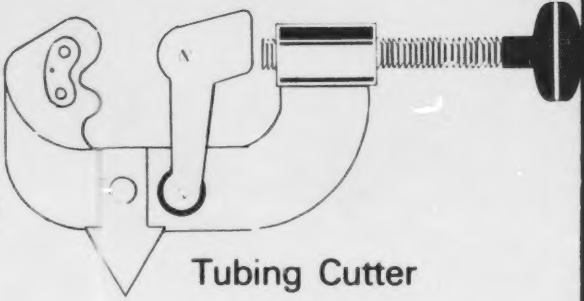
(Continued)



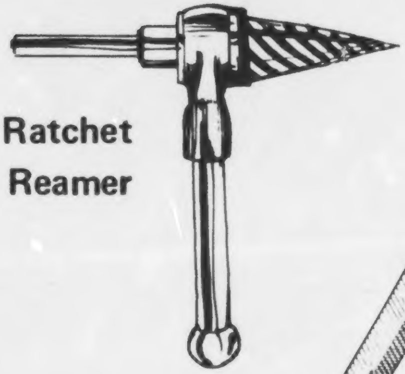
Pipe Cutter



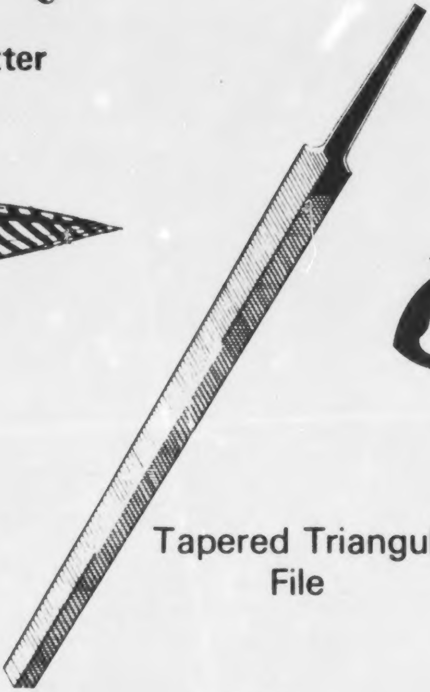
Die



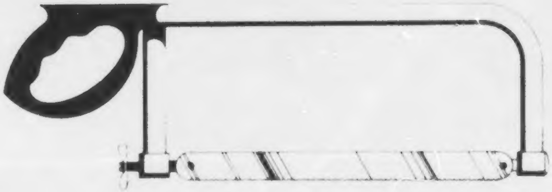
Tubing Cutter



Spiral Ratchet
Pipe Reamer

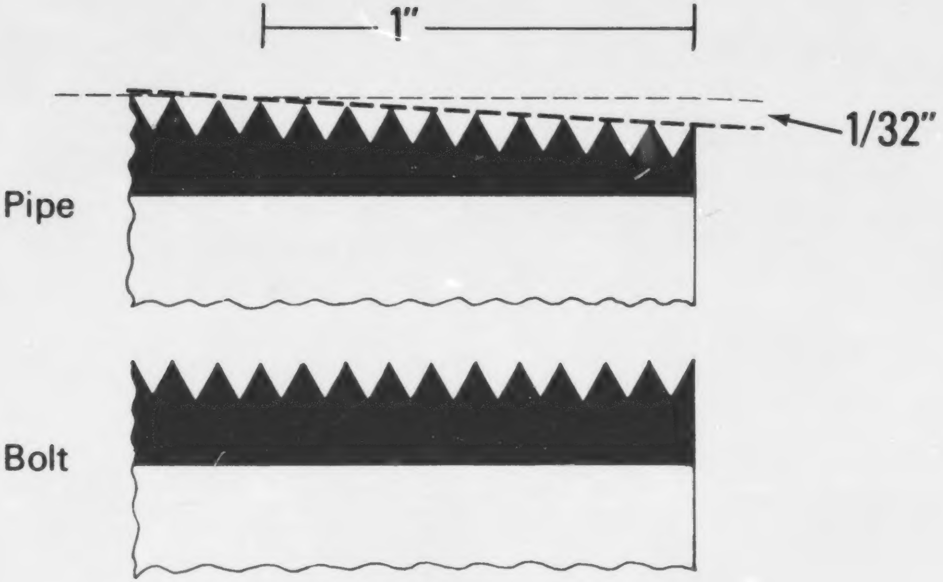


Tapered Triangular
File



Hacksaw

Pipe vs Bolt Threads


1"
1/32"
Pipe
Bolt

PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #1--CUT PIPE

I. Tools and materials

   A. Vise

   B. Tapered triangular file

   C. Ruler or steel tape

   D. Pipe cutter

   E. 3/4 inch pipe, 2 feet

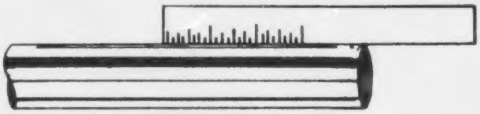
   F. 1/2 inch pipe, 1 foot

II. Procedure

   (NOTE: Using the procedure below, cut two pieces of 3/4 inch pipe eight inches long. Cut one piece of 1/2 inch pipe eight inches long.)

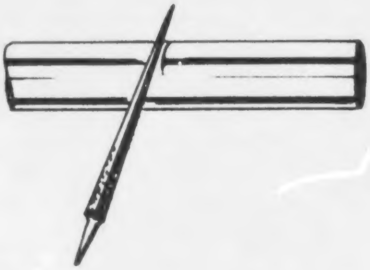
   A. Measure length of pipe desired (Figure 1)

FIGURE 1



   B. Mark desired length with tapered triangular file (Figure 2)

FIGURE 2



   C. Fasten pipe in vise so mark is at least four inches from vise

   D. Place pipe cutter on mark

JOB SHEET #1

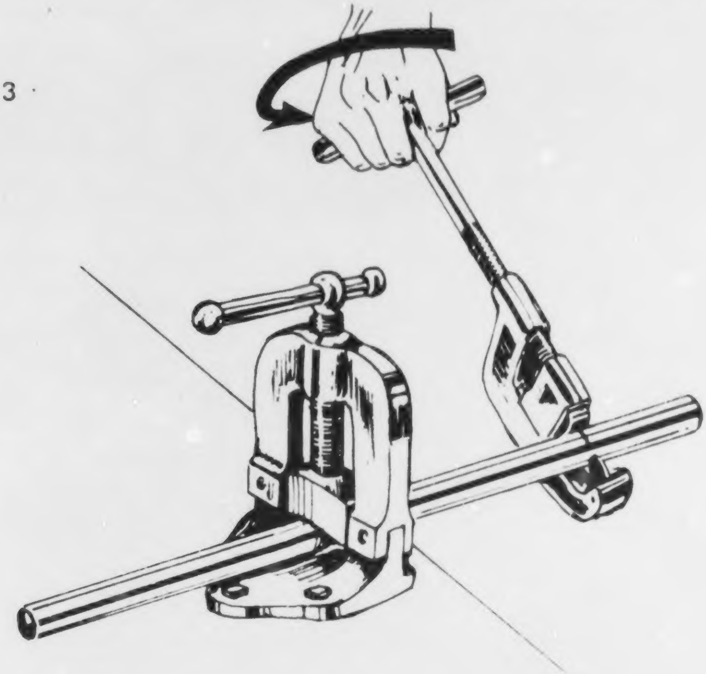
E. Tighten cutter by screwing in handle until cutting wheel is snug against pipe

F. Hold handle perpendicular to the pipe and tighten handle until cutting wheel penetrates metal

(CAUTION: Tighten only a quarter of a turn to eliminate breaking cutter and flattening pipe.)

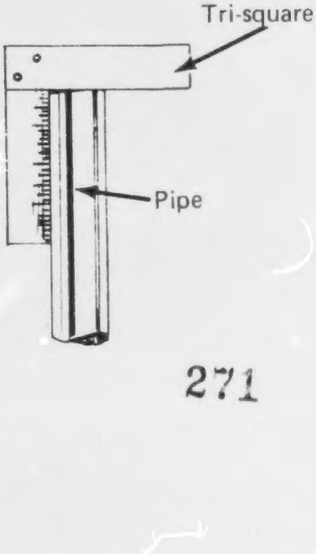
G. Turn pipe cutter 1/4 turn per revolution until pipe is cut off (Figure 3)

FIGURE 3



H. Check cut for squareness (Figure 4)

FIGURE 4



PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #2--REAM PIPE

I. Tools and materials

A. Vise

B. Burr reamer

C. Carpenter brace

D. 3/4 inch pipe, 8 inches long, 2 pieces

E. 1/2 inch pipe, 8 inches long, 1 piece

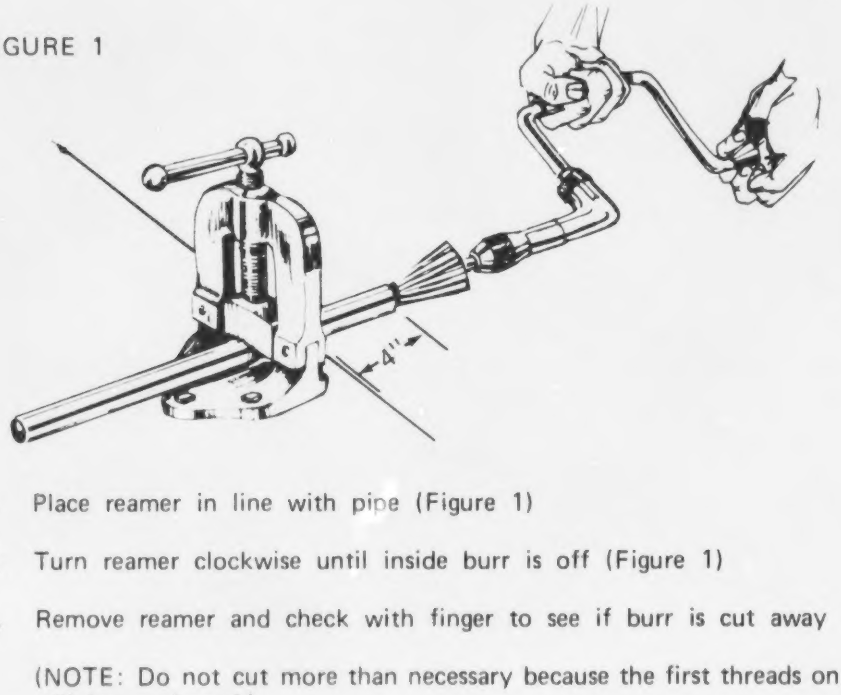
(NOTE: Use the pipe cut in Job Sheet #1.)

II. Procedure

(NOTE: Using the procedure below, ream two pieces of 3/4 inch pipe eight inches long. Ream one piece of 1/2 inch pipe eight inches long.)

A. Fasten pipe in vise allowing four inches to extend from vise (Figure 1)

FIGURE 1



B. Place reamer in line with pipe (Figure 1)

C. Turn reamer clockwise until inside burr is off (Figure 1)

D. Remove reamer and check with finger to see if burr is cut away

(NOTE: Do not cut more than necessary because the first threads on pipe will be weakened.)

PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #3--THREAD PIPE

I. Tools and materials

A. Vise

B. Flat file

C. Dies, 2, 3/4" and 1/2"

D. Die stock

E. Cutting oil

F. Wire brush

G. 3/4 inch pipe, 8 inches long, 2 pieces

H. 1/2 inch pipe, 8 inches long, 1 piece

(NOTE: Use the pipe cut in Job Sheet #1.)

II. Procedure

(NOTE: Using the procedure below, thread the pieces of pipe that were used in Job Sheets #1 and #2. Thread pipes on both ends.)

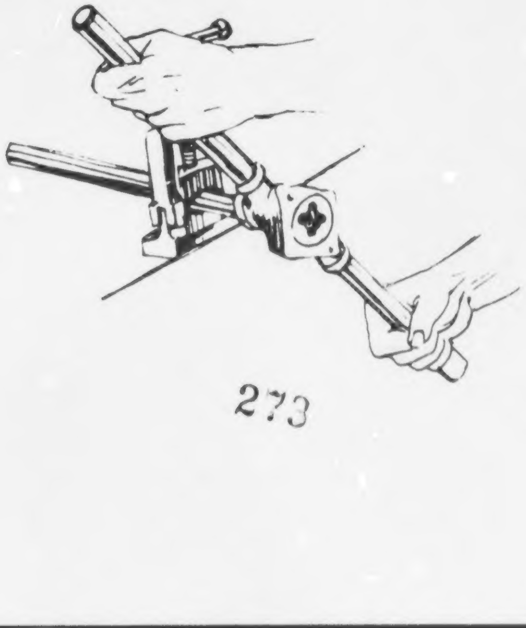
A. Place pipe in vise, allowing six inches to extend from vise

B. File off any outside burr that may be on pipe end

C. Place proper size die in stock

D. Place pressure against die holder with palm of hand; turn clockwise until die starts cutting threads (Figure 1)

FIGURE 1



JOB SHEET #3

E. Use cutting oil on the threading area at all times

F. Continue threading until one thread is past the die

G. Back off die and inspect threads

H. Use wire brush and clean threads

PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #4--JOIN OR FIT PLASTIC PIPE

I. Tools and materials

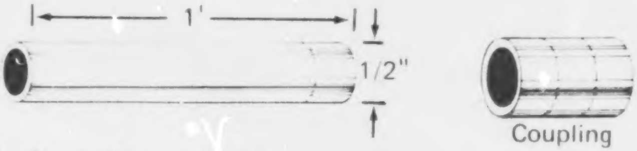
- A. Hacksaw
- B. 1/2" plastic pipe, 2 feet
- C. Plastic pipe cement
- D. 1/2" plastic coupling
- E. Clean rags
- F. Solvent for cleaning plastic pipe

II. Procedure

A. Cut two pieces of 1/2" plastic pipe one foot in length (Figure 1)

(NOTE: Make sure ends are cut square.)

FIGURE 1



B. Smooth the ends

C. Clean ends of pipe and coupling with clean rag and solvent or very fine emery cloth

D. Spread cement evenly over inside of coupling

E. Insert pipe and give 1/4 turn

(NOTE: Make sure the pipe is pushed into the coupling as far as it will go. See Figure 2.)

FIGURE 2

F. Repeat steps C, D, and E for other end of coupling

G. Let set until dry

PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #5--SWEAT A COPPER JOINT

I. Tools and materials

- A. 1/2" copper tubing, 2 pieces
- B. 1/2" copper tubing coupling sweat joint
- C. Solder
- D. Flux
- E. Oxyacetylene torch
- F. Tubing cutter
- G. Reaming tool
- H. Clean rags

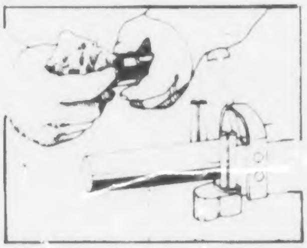
II. Procedure

- A. Cut tubing to desired length

  (CAUTION: Do not flatten pipe.)

- B. Remove burrs, inside and out (Figure 1)

FIGURE 1

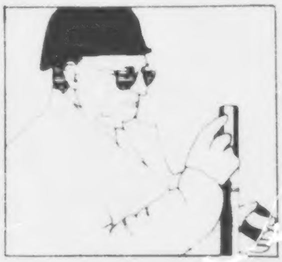


- C. Clean the surface to be soldered by coating with flux and wiping clean

JOB SHEET #5

D. Apply a thin, even coat of flux (Figure 2)

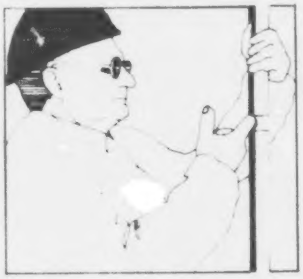
FIGURE 2



E. Join tubing and fitting; give a 1/4 twist (Figure 3)

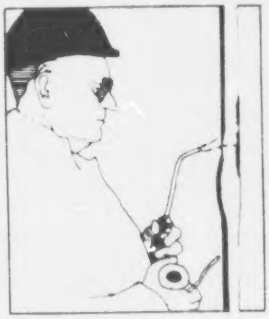
(NOTE: This will spread the flux.)

FIGURE 3



F. Apply heat to the heaviest part of the fitting first, then move to the opening where solder enters (Figure 4)

FIGURE 4

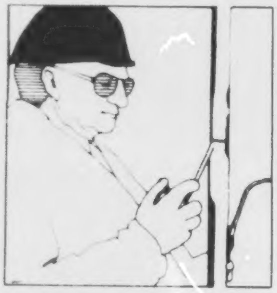


JOB SHEET #5

G. Apply solder to joint (Figure 5)

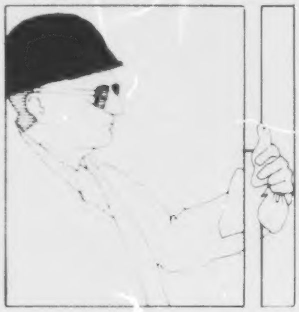
(NOTE: Heat melts the solder and capillary action draws it into the clearance spacer of the joint.)

FIGURE 5



H. Wipe joint clean while solder is molten (Figure 6)

FIGURE 6



PLUMBING AND PIPE FITTING
UNIT VI

JOB SHEET #6--CUT AND FLARE COPPER TUBING

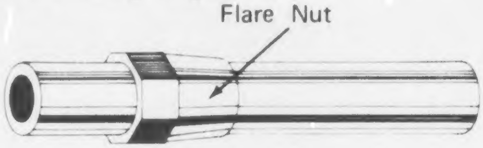
I. Tools and materials

- A. 3/8" flare nuts, 2
- B. 3" copper union, 1
- C. 3/8" copper tubing, 6" long, 2 pieces
- D. Tubing cutter
- E. Flaring tool
- F. Reamer
- G. File

II. Procedure

- A. Cut tubing to desired length
- B. Remove burrs, inside and out
- C. Place flare nut on tubing (Figure 1)

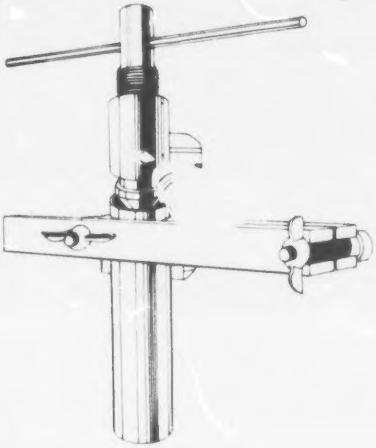
FIGURE 1



- D. Place tubing in flaring tool and secure (Figure 2)

(NOTE: End of tubing should be flush with flaring tool.)

FIGURE 2



PLUMBING AND PIPE FITTING
UNIT VI

TEST

NAME ______________________________ SCORE ______________________

1. Match terms associated with plumbing to the correct definitions.

______a. Pipe which drains the liquid from the septic tank to the soil

______b. Pipe which carries all the sewage from the house

______c. Water-sealed bend or chamber in a waste pipe

______d. Soil, waste, or ventilating pipe

______e. Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste

______f. Piece used to join pipe, to provide opening in pipe, and to change the direction of pipe

______g. Appliance connected to the plumbing

______h. Any pipe that receives the discharge of waste water from house fixtures

______i. Tank which receives all the sewage piped into it and allows the process of sewage treatment to take place

______j. Polyvinyl chloride

1. House drain
2. Stack
3. Fixture
4. Septic tank
5. Lateral pipe
6. Plumbing
7. Soil pipe
8. Fitting
9. PVC
10. Trap

2. Match the various kinds of pipe on the right to the correct uses.

______a. Used for water lines

______b. Used for natural and LP gas, oil, and air lines

______c. Plastic pipe used in water or sewage systems, air lines, and natural gas lines

______d. Used in sewage system; generally a cast iron pipe

1. PVC
2. Black
3. Soil
4. Galvanized

______e. Used for traps and drains

______f. Used for water, refrigeration, and waste systems

______g. Used in water systems

______h. Used in sewage systems

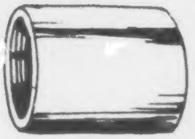
5. Brass or lead

6. Copper tubing

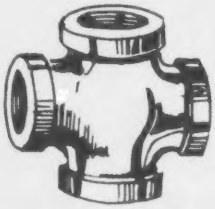
7. Cast iron

8. Plastic

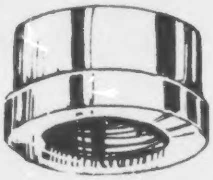
3. Identify the following common pipe fittings and types of valves by writing the correct names in the blanks provided.



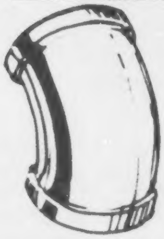
a. ____________



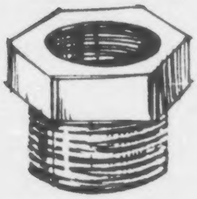
b. ____________



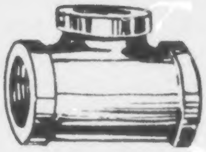
c. ____________



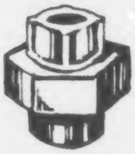
d. ____________



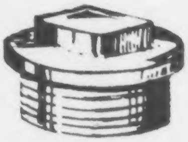
e. ____________



f. ____________



g. ____________



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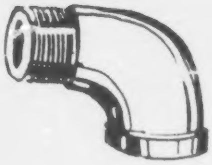
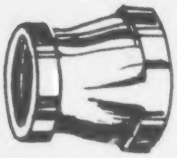


i. ____________

j. ____________



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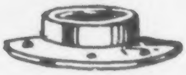

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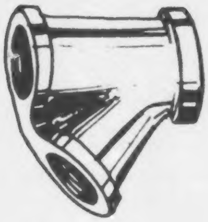
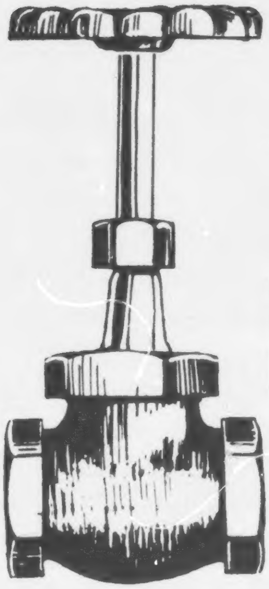
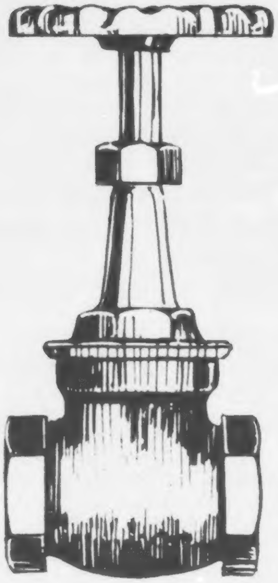


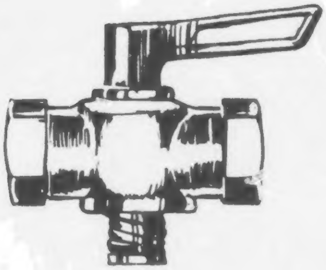
m. ______________________



n. ______________________



o. ______________________



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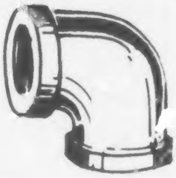


q. ______________________

4. Select from the list below reasons for using pipe joint compound. Place an "X" in the appropriate blanks.

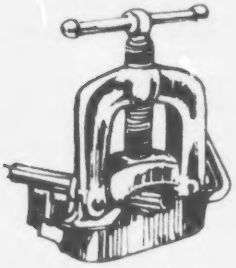
______a. Insures tight joints

______b. Fit together easier

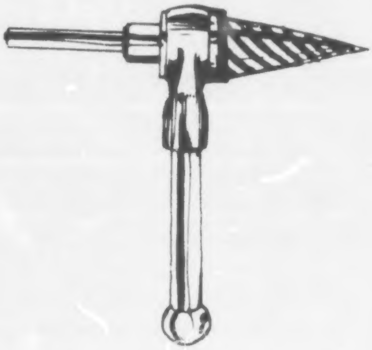
______c. Prevents threads from rusting

______d. Can be disassembled easier

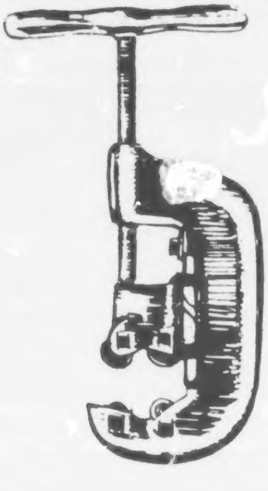
5. Identify the following tools used in plumbing by writing the correct names in the blanks provided.



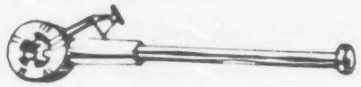
a. ______________________



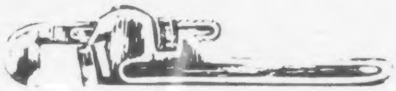
b. ______________________



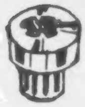
c. ______________________



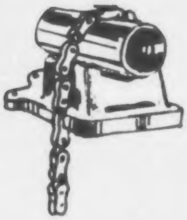
d. ______________________



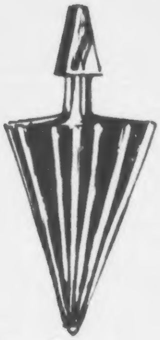
e. ______________________



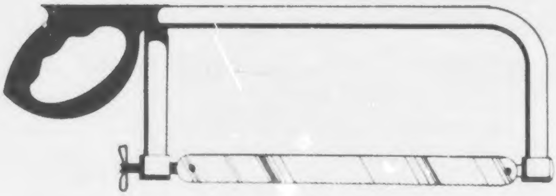
f. ____________________



g. ____________________

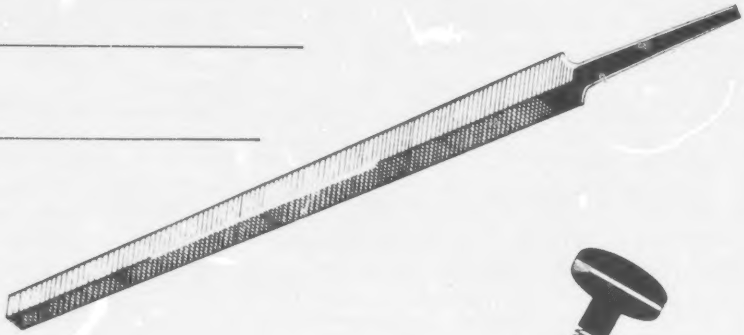


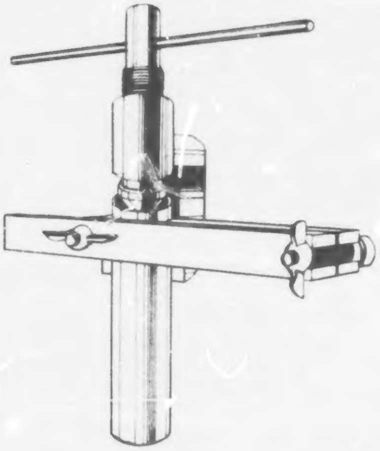
h. ____________________



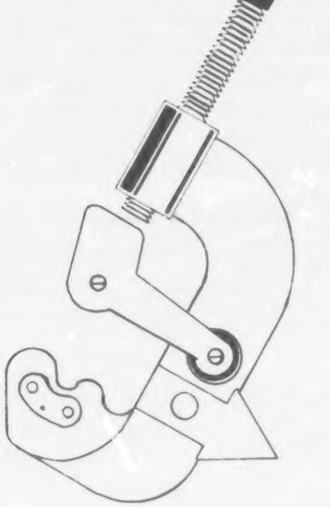
i. ____________________

j. ____________________





k. ____________________



l. ____________________

6. List the reasons for using cutting oil.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

7. Select from the list below common sizes of pipe and copper tubing used in plumbing. Place an "X" in the appropriate blanks.

Pipe	Copper tubing
_____a. 4"	_____h. 2"
_____b. 1"	_____i. 3/8"
_____c. 1 1/4"	_____j. 1/2"
_____d. 1/2"	_____k. 7/16"
_____e. 3"	_____l. 1"
_____f. 2"	_____m. 1 1/4"
_____g. 3/4"	_____n. 1 1/2"

8. Describe how pipe size is determined in relationship to copper tubing.

____

____

____

9. Discuss the differences between pipe, bolt, and copper fitting threads.

____

____

____

____

____

____

10. List the kinds of pipe thread sealing compounds.

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

11. Demonstrate the ability to:

    a. Cut pipe.

    b. Ream pipe.

    c. Thread pipe.

    d. Join or fit plastic pipe.

    e. Sweat a copper joint.

    f. Cut and flare copper tubing.

    (NOTE: If these activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

PLUMBING AND PIPE FITTING
UNIT VI

ANSWERS TO TEST

1. Match terms associated with plumbing to the correct definitions.

5 a. Pipe which drains the liquid from the septic tank to the soil

1 b. Pipe which carries all the sewage from the house

10 c. Water-sealed bend or chamber in a waste pipe

2 d. Soil, waste, or ventilating pipe

6 e. Piping and pipe attachments used to carry water into buildings and to drain away sewage and waste

8 f. Piece used to join pipe, to provide opening in pipe, and to change the direction of pipe

3 g. Appliance connected to the plumbing

7 h. Any pipe that receives the discharge of waste water from house fixtures

4 i. Tank which receives all the sewage piped into it and allows the process of sewage treatment to take place

9 j. Polyvinyl chloride

1. House drain
2. Stack
3. Fixture
4. Septic tank
5. Lateral pipe
6. Plumbing
7. Soil pipe
8. Fitting
9. PVC
10. Trap

2. Match the various kinds of pipe on the right to the correct uses.

4 a. Used for water lines

2 b. Used for natural and LP gas, oil, and air lines

1 c. Plastic pipe used in water or sewage systems, air lines, and natural gas lines

3 d. Used in sewage system; generally a cast iron pipe

1. PVC
2. Black
3. Soil
4. Galvanized

5 e. Used for traps and drains

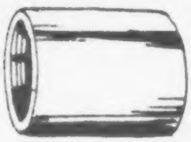
6 f. Used for water, refrigeration, and waste systems

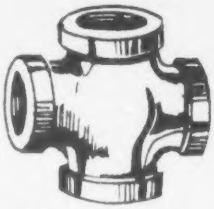
8 g. Used in water systems

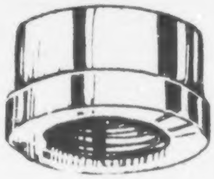
7 h. Used in sewage systems

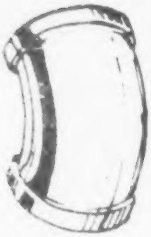
5. Brass or lead
6. Copper tubing
7. Cast iron
8. Plastic

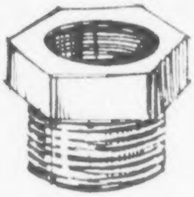
3. Identify the following common pipe fittings and types of valves by writing the correct names in the blanks provided.

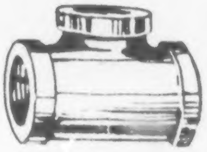

a. Coupling

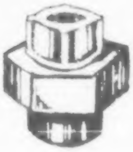

b. Straight cross

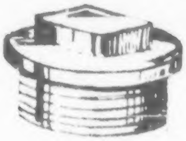

c. Cap

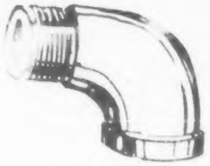

d. 45° elbow

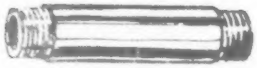

e. Bushing

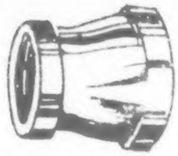

f. T

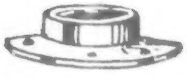

g. Union

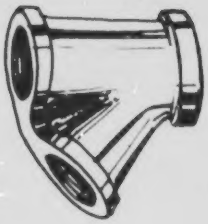

h. Plug


i. 90° street elbow

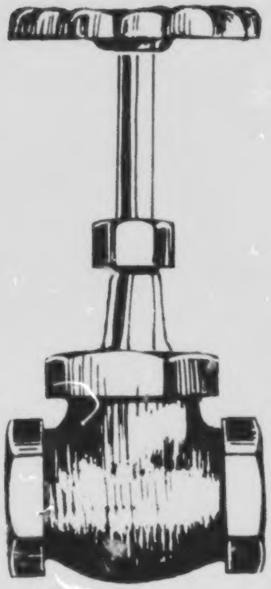

j. Nipple


k. Bell reducer

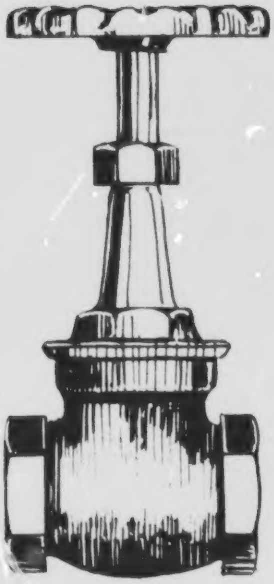

l. Floor flange



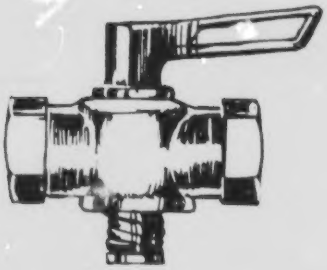
m. Y



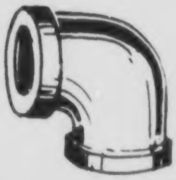
n. Globe valve



o. Gate valve



p. Gas stop



q. 90° Elbow

4. Select from the list below reasons for using pipe joint compound. Place an "X" in the appropriate blanks.

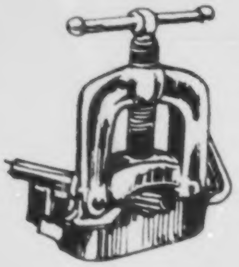
___X___ a. Insures tight joints

______ b. Fit together easier

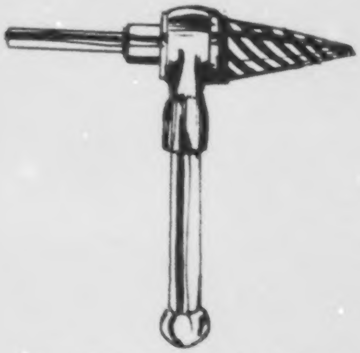
___X___ c. Prevents threads from rusting

______ d. Can be disassembled easier

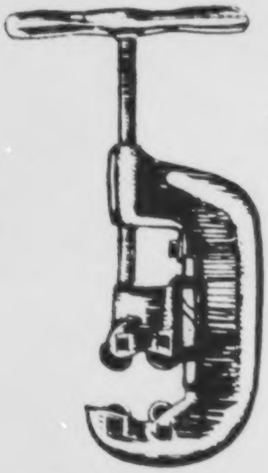
5. Identify the following tools used in plumbing by writing the correct names in the blanks provided.



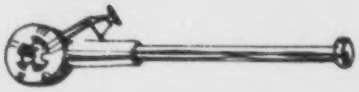
a. Bench yoke vise



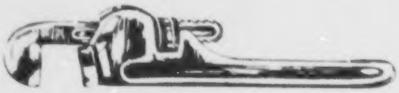
b. Spiral ratchet pipe reamer



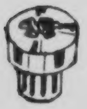
c. Pipe cutter



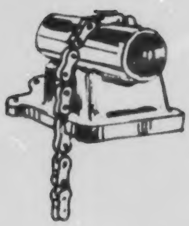
d. Small ratchet threader



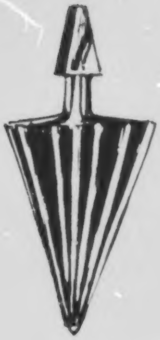
e. Pipe wrench



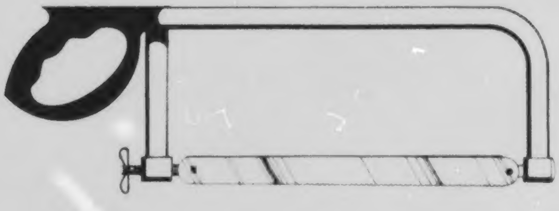
f. Die



g. Chain vise

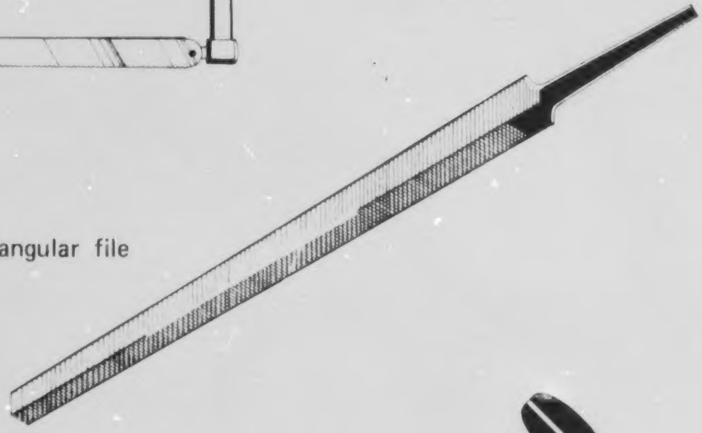


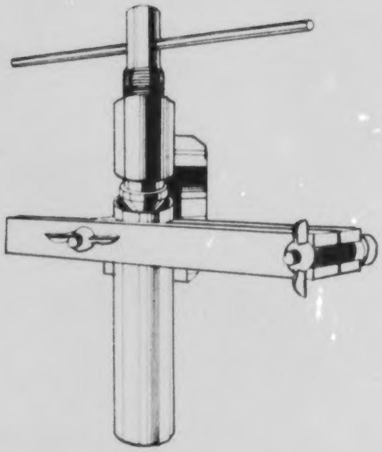
h. Burr reamer



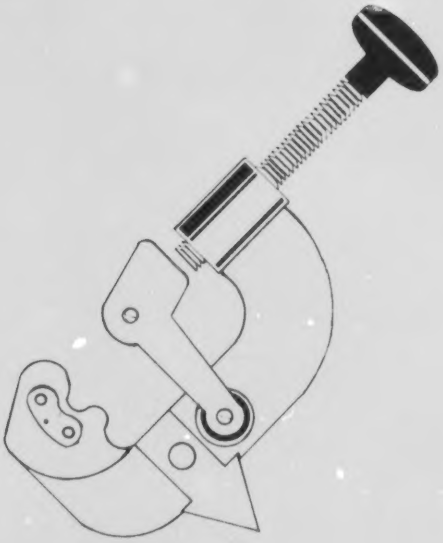
i. Hacksaw

j. Tapered triangular file





k. Flaring tool



l. Tubing cutter

6. List the reasons for using cutting oil.

   a. Allows tools to cut smoother

   b. Permits tools to cut easier

   c. Lengthens lifetime of tools

   d. Removes burrs and cuttings from dies

7. Select from the list below common sizes of pipe and copper tubing used in plumbing. Place an "X" in the appropriate blanks.

   Pipe

   _____ a. 4"

   __X__ b. 1"

   __X__ c. 1 1/4"

   __X__ d. 1/2"

   _____ e. 3"

   _____ f. 2"

   __X__ g. 3/4"

   Copper tubing

   _____ h. 2"

   __X__ i. 3/8"

   __X__ j. 1/2"

   __X__ k. 7/16"

   _____ l. 1"

   _____ m. 1 1/4"

   _____ n. 1 1/2"

8. Describe how pipe size is determined in relationship to copper tubing.

   a. Pipe size determined by inside diameter

   b. Tubing size determined by outside diameter

   c. Pipe wall generally thicker

9. Discuss the differences between pipe, bolt, and copper fitting threads.

   a. Pipe

      1) Tapers 1/32" per inch in length

      2) Has standard threads

   b. Bolt

      1) Straight

      2) National coarse

      3) National fine

   c. Copper fitting--National fine threads

10. List the kinds of pipe thread sealing compounds.

    a. White lead

    b. Red lead

    c. Oil and graphite

    d. Teflon tape

11. Demonstrate the ability to:

    a. Cut pipe.

    b. Ream pipe.

    c. Thread pipe.

    d. Join or fit plastic pipe.

    e. Sweat a copper joint.

    f. Cut and flare copper tubing.

    (NOTE: The performance skills should be evaluated to the satisfaction of the instructor.)

[redacted]

SERVICING SMALL ENGINES
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with servicing small engines to the definitions. The student should be able to identify the different types of air cleaners, fuel filters, carburetors, and magnetos and demonstrate skills in servicing small gasoline engines. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with servicing small engines to the correct definitions.
2. Name the solutions used in cleaning an engine.
3. Identify types of air cleaners.
4. Identify types of fuel filters.
5. Identify types of carburetors.
6. Identify types of magnetos.
7. Demonstrate the ability to:
    a. Clean and inspect crankcase and accessories.
    b. Clean and inspect cooling system.
    c. Service oil-bath air cleaner.
    d. Service oiled-filter air cleaner.
    e. Service dry-filter air cleaner.
    f. Service sediment bowl fuel strainer.
    g. Service screen type fuel strainer.
    h. Service crankcase breather.
    i. Change crankcase oil.
    j. Check spark plug for proper operation.

k. Clean and service spark plugs.

l. Replace ignition contact points and condenser on internal magneto.

m. Replace ignition contact points and condenser on external magneto.

n. Service float type carburetor.

SERVICING SMALL ENGINES
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Unit references:

  A. *Small Engine Care, Operation, Maintenance, and Repair.* Vol. I American Association for Agricultural Engineering and Vocational Agriculture.

  B. *Briggs and Stratton Repair Instructions III.* Milwaukee, Wisconsin: Briggs and Stratton Corporation.

  C. *General Theories of Operation.* Milwaukee, Wisconsin: Briggs and Stratton Corporation.

  D. *Small Gasoline Engines Student Handbook.* University Park: Pennsylvania State University, College of Agriculture, Department of Agricultural Education.

SERVICING SMALL ENGINES
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Butterfly (throttle) valve--Device located in the manifold which controls the fuel and air

   B. Choke valve--Gate or valve which allows passage of gas or fluid in one direction only; valve which provides a higher fuel-to-air ratio by restricting air inlet

   C. Spark gap--Space between the electrodes of a spark plug through which the spark jumps

   D. Detonation or knock--Hammering force on the piston rather than a uniform pushing force

   E. Air cleaner--Device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

   F. Carburetor--Device for automatically mixing fuel in the proper proportion with air to produce a combustible gas

   G. Magneto--Alternator with permanent magnets used to generate current for the ignition in an internal combustion engine

   H. Ignition contact points (breaker points)--Pair of points, one stationary and the other operated by a cam, to make and break the primary ignition circuit; usually made of tungston, platinum, or silver

   I. Condenser--Device for temporarily collecting and storing a surge of electrical current for later discharge

II. Engine cleaning solutions

   A. Commercial solvent called *degreaser*

   B. Petroleum solvents

      1. Kerosene

      2. Diesel fuel

   C. Live steam

   D. Detergent solvent (car wash)

INFORMATION SHEET

III. Types of air cleaners (Transparency 1)

   A. Oil-bath

   B. Oiled-filter

   C. Dry-filter

IV. Types of fuel filters (Transparency 2)

   A. Combination screen and sediment bowl

   B. Screen in fuel tank

   C. Strainer on fuel pick-up hose

V. Types of carburetors (Transparency 3)

   A. Float

   B. Suction-lift

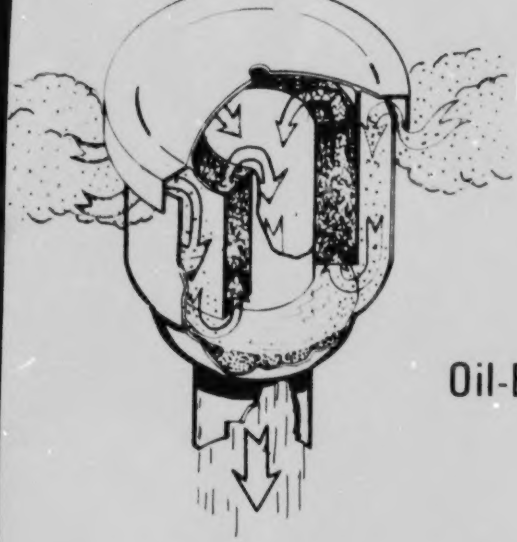
   C. Diaphragm

VI. Types of magnetos (Transparency 4)

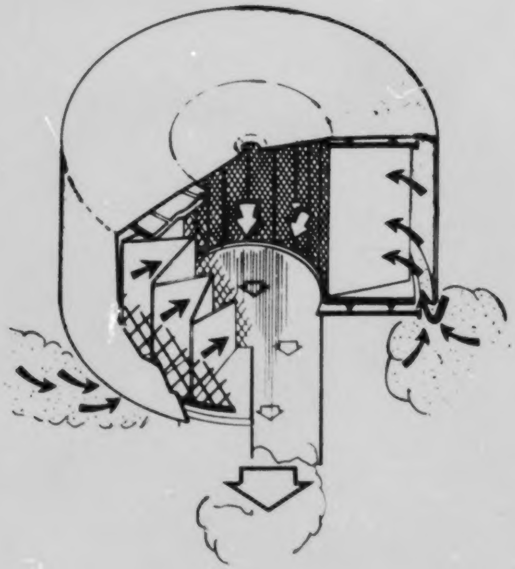
   A. Internal (flywheel) magneto

   B. External magneto

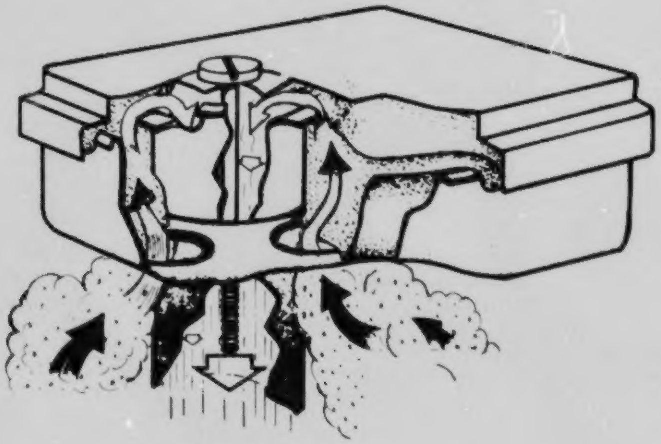
Types of Air Cleaners



Oil-Bath

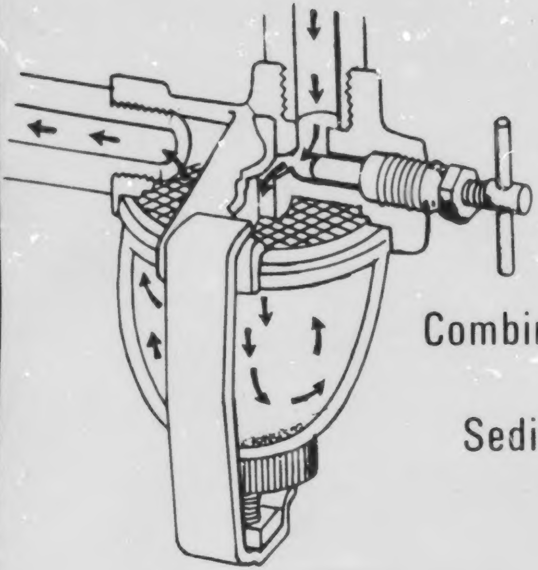


Dry-Filter

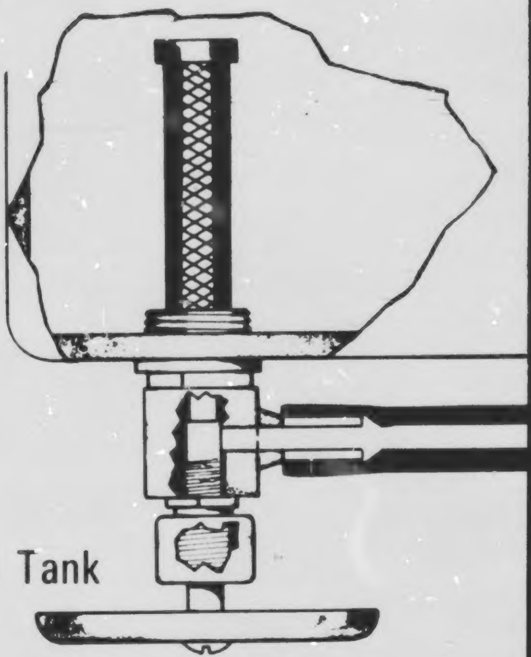


Oiled-Filter

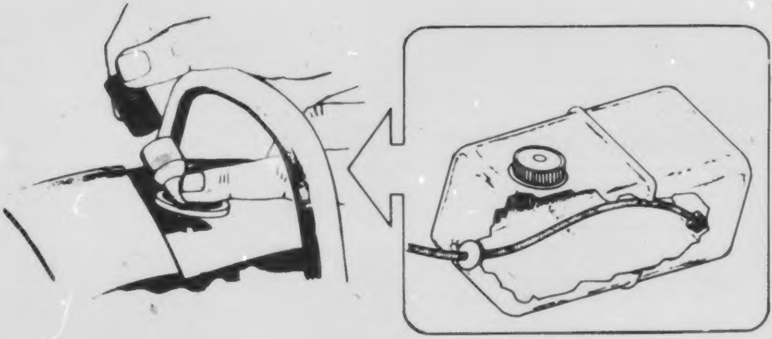
Types of Fuel Filters



Combination Screen
and
Sediment Bowl

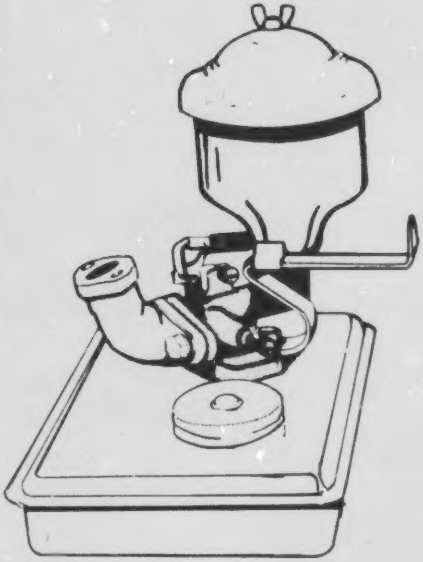


Screen in Fuel Tank

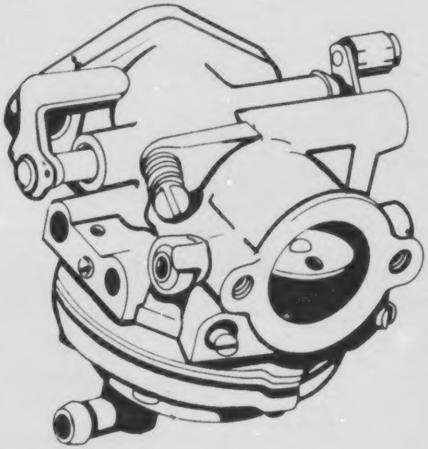


Strainer on Fuel
Pick-up Hose

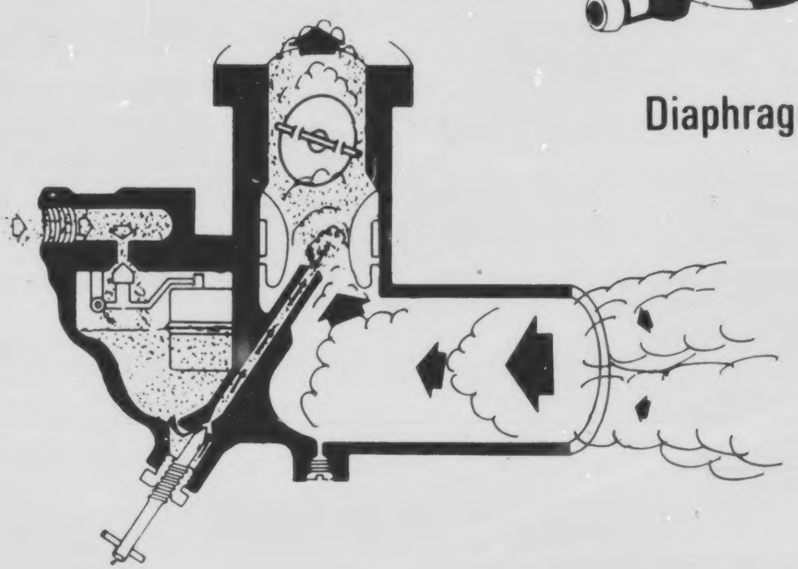
Types of Carburetors



Suction-Lift

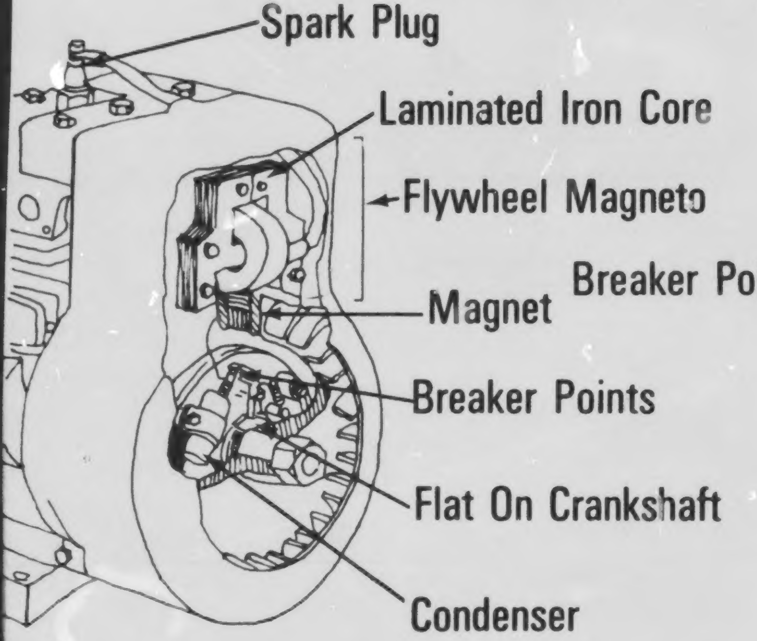


Diaphragm

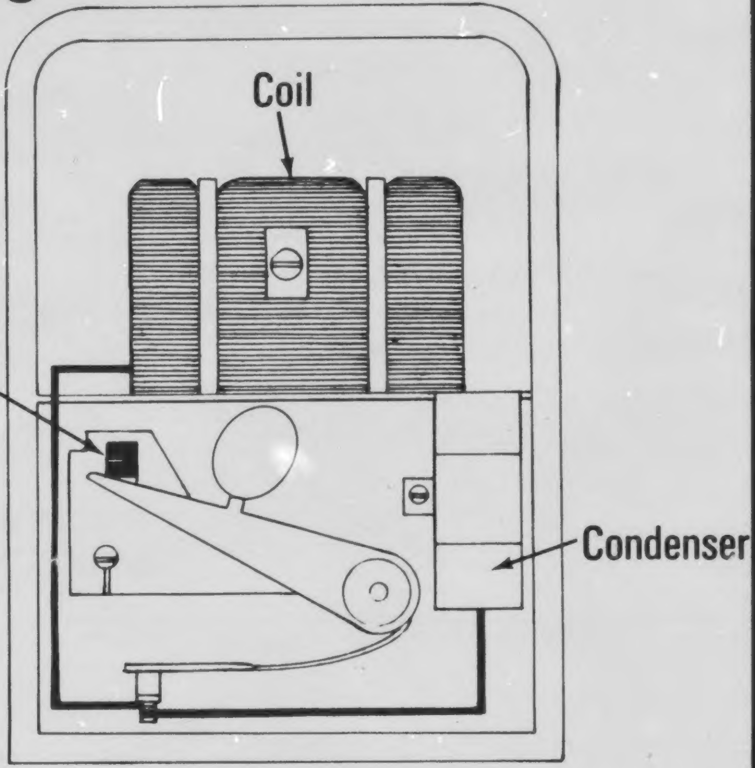


Float

Types of Magnetos


Spark Plug
Laminated Iron Core
Flywheel Magneto
Magnet
Breaker Points
Flat On Crankshaft
Condenser

INTERNAL (FLYWHEEL)


Coil
Breaker Points
Condenser

EXTERNAL

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #1--CLEAN AND INSPECT CRANKCASE AND ACCESSORIES

I. Tools and materials

   A. Standard screwdrivers, 4" and 6"

   B. Phillips screwdrivers, 4" and 6"

   C. Socket set including:

      1. 3/8"

      2. 7/16" (deep)

      3. 1/2"

      4. 5/8"

      5. 9/16"

      6. 3/8" ratchet

   D. Open-end wrenches same as sockets

   E. Wire brush

   F. Empty pan for cleaning solvent

   G. Paint brush

   H. Water hose with nozzle

   I. Scraper or putty knife

   J. Solvent

   K. Hand sprayer

   L. Fire extinguisher

   M. Pressurized air

   (NOTE: Do not use gasoline for cleaning an engine. It is highly flammable and an extreme fire hazard. If a degreaser is used, check the instructions on the can.)

JOB SHEET #1

II. Procedure

A. Allow the engine to cool if it has been running

B. Remove the blower shroud and cylinder baffles

C. Inspect for oil and fuel leaks

D. Remove air cleaner and cover air cleaner opening

(NOTE: Cover carburetor intake with a piece of plastic sheeting. Use a rubber band to hold plastic in place.)

E. Clean the exhaust system

F. Apply solvent on areas that need cleaning

(NOTE: Apply with a paint brush or hand sprayer until you notice a thin, well distributed film.)

G. Allow solvent to set approximately five minutes

H. Remove solvent from the engine surface

1. If you used a degreaser, apply a strong stream of water

2. If you used a petroleum solvent, remove with a strong soap solution

I. Check for areas that have been missed

J. Remove protective covers

K. Replace carburetor air cleaner

L. Replace blower shroud and cylinder baffles

M. Start engine and operate for three to five minutes

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #2--CLEAN AND INSPECT COOLING SYSTEM

I. Tools and materials

- A. Standard screwdrivers, 4" and 6"
- B. Phillips screwdrivers, 4" and 6"
- C. Socket set
- D. Open-end wrench set
- E. Wire brush
- F. Scraper or putty knife
- G. Pressurized air

II. Procedure

A. Close the fuel shut-off valve

(NOTE: Not all engines have shut-off valves. If there is one, it may be either a part of the sediment bowl or a single unit.)

B. Remove fuel tank if necessary for removing the flywheel shroud

C. Remove the recoil starter or screened sheave if equipped with a self-starter

D. Remove the blower shroud

E. Remove remaining baffles and deflectors that direct air from shroud and over end area of cylinder

(NOTE: Do not operate the engine with the shroud and baffles removed.)

F. Clean inside of shroud and baffles with a small bristle brush or a putty knife

G. Clean intake screen by washing in solvent

H. Clean dirt from cylinder fins

I. Clean dirt from blower flywheel fins

J. Inspect engine for cracks, blemishes, and broken parts

K. Reassemble parts in reverse order

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #3--SERVICE OIL-BATH AIR CLEANER

I. Tools and materials

  A. Standard screwdrivers, 4" and 6"

  B. Phillips screwdrivers, 4" and 6"

  C. Container for washing parts

  D. Clean rags

  E. Wooden scraper

  F. Paint brush

  G. Solvent

  (NOTE: Do not use gasoline, naptha, or benzine. They are extremely flammable.)

  H. Pressurized air

II. Procedure

  A. Disconnect the spark plug wire

  B. Loosen oil cup or cover and remove the air cleaner

    1. Secured by bail wire

    2. Secured by wing nut

    3. Secured by threaded stud

  C. Cover the exposed air intake

  D. Check depth of sediment deposit in bottom of oil cups

  E. Throw away dirty oil

  F. Clean cup, filter, and other parts with solvents

  G. Check air intake pipe to the carburetor for dirt accumulation

  H. Refill cup with oil to Oil Level

  I. Remove cover from intake

  J. Assemble the air cleaner, install, and tighten

  K. Reconnect the spark plug wire

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #4--SERVICE OILED-FILTER AIR CLEANER

I. Tools and materials

    A. Standard screwdrivers, 4" and 6"

    B. Phillips screwdrivers, 4" and 6"

    C. Container for washing parts

    D. Clean rags

    E. Soap

    F. Paint brush

    G. Pressurized air

II. Procedure

    A. Disconnect the spark plug wire

    B. Clean area around air cleaner

    C. Remove filter element cover

    D. Remove filter element

    E. Check condition of the filter element and other parts of the air cleaner

    F. Cover carburetor air intake

    G. Clean filter

    H. Dry filter element

    I. Remove protective cover from the carburetor intake

    J. Clean the carburetor intake

    K. Oil the filter element with a few drops of oil

    L. Install filter element

    M. Install cover

    N. Reconnect spark plug wire

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #5--SERVICE DRY-FILTER AIR CLEANER

I. Tools and materials

  A. Standard screwdrivers, 4" and 6"

  B. Phillips screwdrivers, 4" and 6"

  C. Clean rags

  D. Pressurized air

II. Procedure

  A. Disconnect the spark plug wire

  B. Clean the area around the air cleaner

  C. Remove the filter element cover

  D. Remove the air filter element

  E. Cover the carburetor air intake with cloth or plastic

  F. Check condition of filter element and other parts

  G. Clean air filter element

  (NOTE: If filter element is paper, clean by tapping it on a flat surface.)

  (CAUTION: Do not wash it unless instructed to do so by the manufacturer.)

  H. Remove protective cover from the carburetor intake

  I. Clean filter cover and carburetor intake

  J. Replace filter element

  K. Replace cover

  L. Reconnect spark plug wire

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #6--SERVICE SEDIMENT BOWL FUEL STRAINER

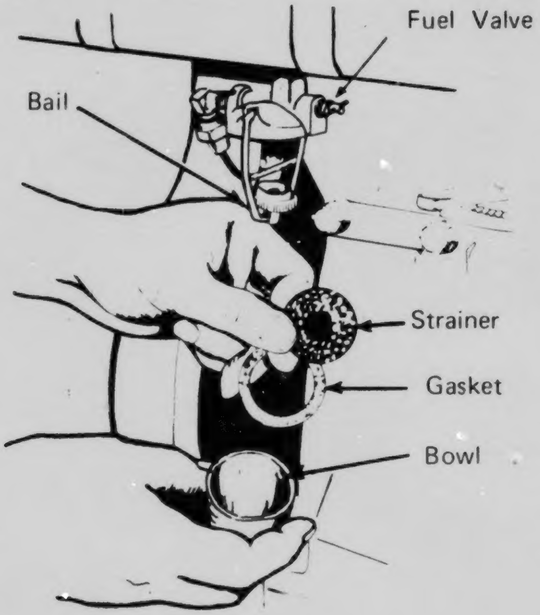
I. Tools and materials

- A. Open-end wrenches, 7/16" and 1/2"
- B. Combination pliers
- C. Solvents
- D. Pan for cleaning parts
- E. Cleaning rags
- F. New gasket for glass bowl
- G. Fire extinguisher
- H. Pressurized air

II. Procedure

- A. Disconnect spark plug wire
- B. Close fuel shut-off valve
- C. Loosen jam nut and swing the wire bail to one side (Figure 1)
- D. Remove bowl with a twisting motion (Figure 1)

FIGURE 1



JOB SHEET #6

E. Remove gasket (Figure 1)

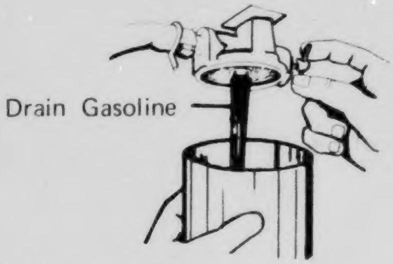
F. Remove strainer (filter) screen (Figure 1)

G. Wash the screen or filter element with solvent

H. Clean and then dry sediment bowl

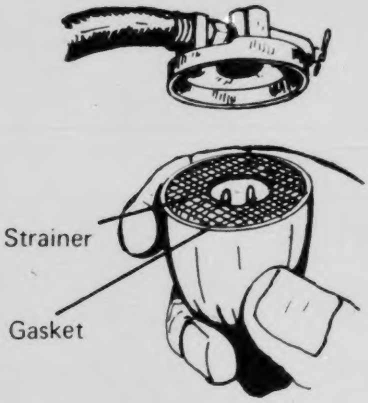
I. Open fuel valve and drain out approximately a cup of fuel (Figure 2) (NOTE: Collect fuel in can to avoid a fire hazard.)

FIGURE 2



J. Install gasket, strainer, and sediment bowl (Figure 3)

FIGURE 3



K. Fill the sediment bowl before tightening the jam nut

L. Tighten bowl against gasket with jam nut

M. Check for leaks before operating engine

N. Reconnect spark plug wire to spark plug

O. Operate engine for a few minutes and recheck for leaks

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #7--SERVICE SCREEN TYPE FUEL STRAINER

I. Tools and materials

   A. Open-end wrenches, 7/16" and 1/2"

   B. Combination pliers

   C. Solvent

   D. Pan for cleaning parts

   E. Cleaning rags

   F. Fire extinguisher

II. Procedure

   A. Disconnect the spark plug wire

   B. Close fuel shut-off valve (if one is installed)

   C. Remove fuel line from tank

   D. Remove fuel shut-off valve and/or fuel strainer from fuel tank if possible

   E. Clean fuel strainer

   F. Replace fuel strainer assembly in reverse order of removal

   G. Reconnect spark plug wire to spark plug

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #8--SERVICE CRANKCASE BREATHER

I. Tools and materials

A. Open-end wrenches, 7/16" and 1/2"

B. Standard screwdriver, 8"

C. Combination pliers

D. Clean rags

E. Solvent

F. Container for cleaning parts

G. New gasket

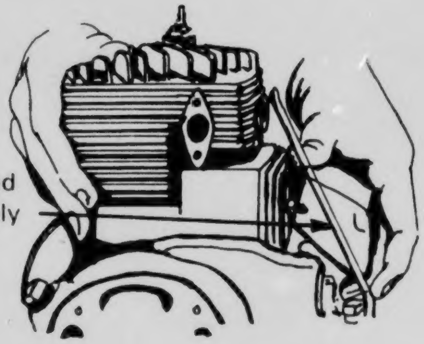
II. Procedure

A. Disconnect spark plug wire

B. Check breather for proper operation

C. Remove crankcase breather cover if installed (Figure 1)

FIGURE 1



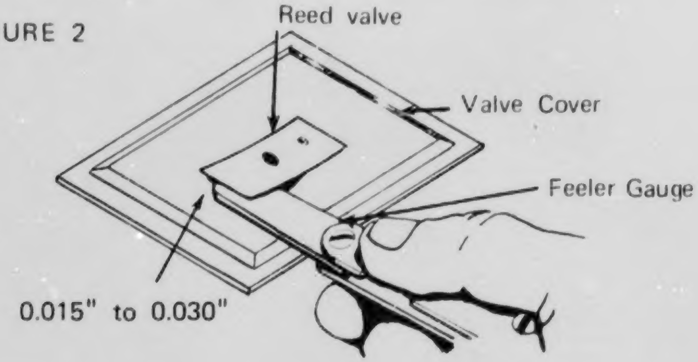
D. Remove the crankcase breather if it is not a part of the cover

JOB SHEET #8

E. Check breather valve for clearance (Figure 2)

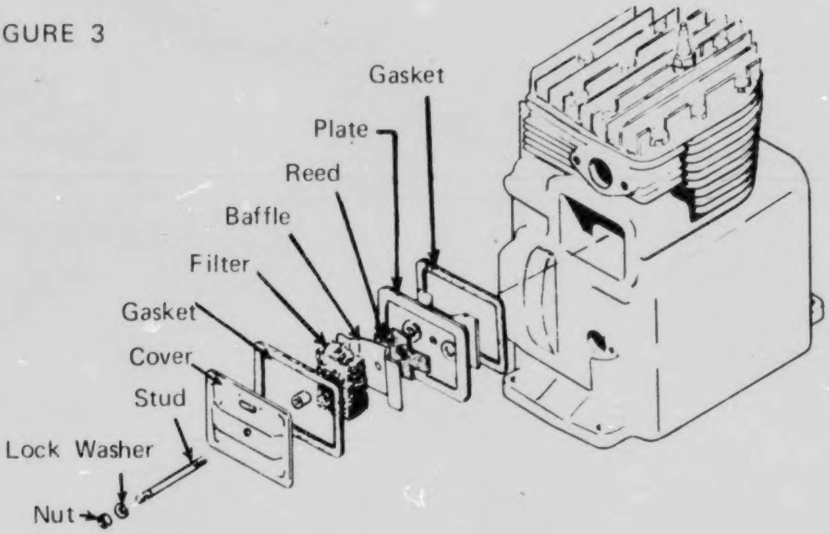
1. Check reed valves with a feeler gauge
2. Be sure clearance is from 0.015" to 0.030"

FIGURE 2


Reed valve
Valve Cover
Feeler Gauge
0.015" to 0.030"

F. Disassemble crankcase breather (Figure 3)

FIGURE 3


Gasket
Plate
Reed
Baffle
Filter
Gasket
Cover
Stud
Lock Washer
Nut

G. Clean parts in petroleum solvent

H. Reassemble and install breather

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #9--CHANGE CRANKCASE OIL

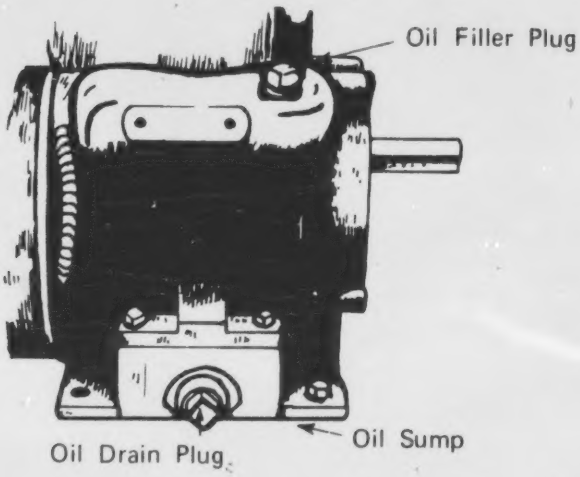
I. Tools and materials

- A. Standard screwdriver, 8"
- B. Combination pliers
- C. End wrenches, 7/16", 1/2", 9/16", and 5/8"
- D. Funnel
- E. Oil as recommended
- F. Container for old oil
- G. Clean rags
- H. Fire extinguisher

II. Procedure

- A. Operate engine until it is thoroughly heated
- B. Stop engine and disconnect the spark plug wire
- C. Locate drain plug (Figure 1)
  1. Bottom of oil sump
  2. Under oil sump
  3. Some motors drain through filler neck

FIGURE 1



JOB SHEET #9

D. Clean dirt from around plug before removing plug

E. Remove drain plug

F. Allow crankcase to drain for approximately five minutes

G. Replace drain plug

H. Refill crankcase with new oil

(NOTE: Use type of oil recommended in the operator's manual.)

I. Connect spark plug wire and start engine

J. Check for oil leaks

K. Stop engine

L. Recheck oil level

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #10--CHECK SPARK PLUG FOR PROPER OPERATION

I. Tools and materials

A. Spark plug deep sockets, 13/16" x 3/8" and 3/4" x 3/8" drive

B. Torque wrench, 3/8" drive

C. Feeler gauge

D. Ignition file

E. Pen knife

F. Wire brush

G. Small paint brush

H. Pan of petroleum solvent

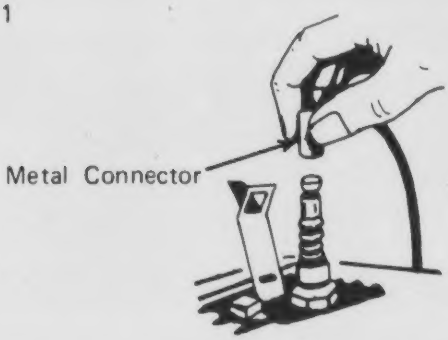
I. Adjustable gap spark tester

J. Fire extinguisher

II. Procedure

A. Disconnect the spark plug wire from the spark plug (Figure 1)

FIGURE 1

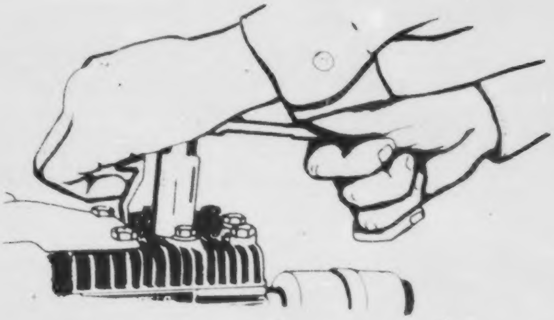


B. Loosen plug one or two turns and then remove dirt

JOB SHEET #10

C. Remove the spark plug (Figure 2)

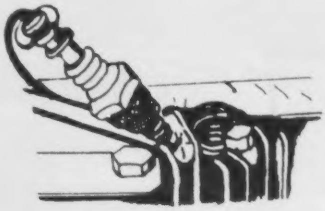
FIGURE 2



D. Reconnect the spark plug wire

E. Ground spark plug to the engine (Figure 3)

FIGURE 3



F. Crank the engine one or two turns

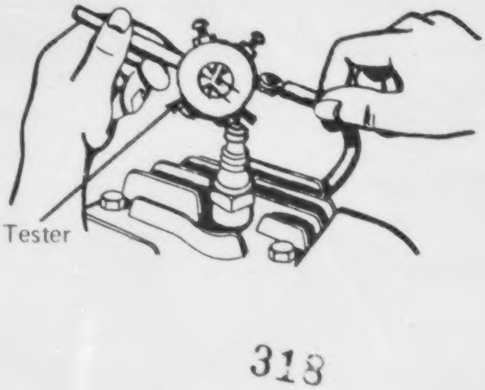
G. Observe the spark at the electrode

(NOTE: If there is no spark or if spark is weak, proceed to next step.)

H. Disconnect the spark plug wire from the spark plug

I. Hold end of the spark plug wire approximately 1/4 inch from the cylinder head or use a spark tester (Figure 4)

FIGURE 4



Adjustable Gap Spark Tester

JOB SHEET #10

J. Crank the engine one or two turns

K. Observe the spark between spark plug wire and the cylinder head

(NOTE: If the spark is blue-orange color, the ignition system is okay; the trouble is in the spark plug.)

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #11--CLEAN AND SERVICE SPARK PLUGS

I. Tools and materials

   A. Spark plug deep sockets, 13/16" x 3/8" and 3/4" x 3/8" drive

   B. Torque wrench, 3/8" drive

   C. Feeler gauge

   D. Ignition file

   E. Pen knife

   F. Wire brush

   G. Small paint brush

   H. Pan of petroleum solvent

   I. Fire extinguisher

II. Procedure

   A. Check the condition of the plugs

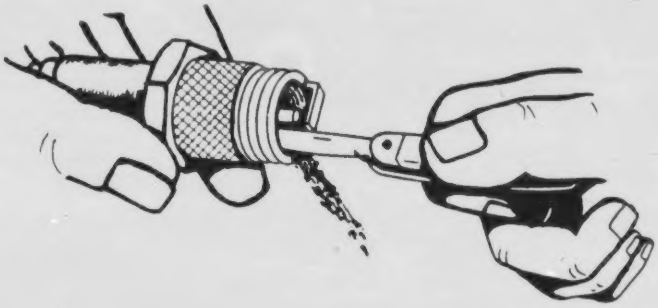
   B. Remove oil deposits from plugs

   C. Clean threads with wire brush

   (NOTE: Do not brush the insulator. It will leave a metallic film which may provide an electrical short to ground.)

   D. Remove deposits from plugs (Figure 1)

FIGURE 1



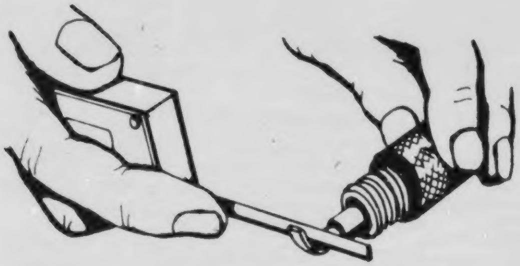
JOB SHEET #11

E. Blow loose materials from plug with compressed air

F. Bend the ground electrode enough to allow room for a thin point file (Figure 2)

(NOTE: Bend just enough to allow room for file. Too much bending will break the ground electrode.)

FIGURE 2



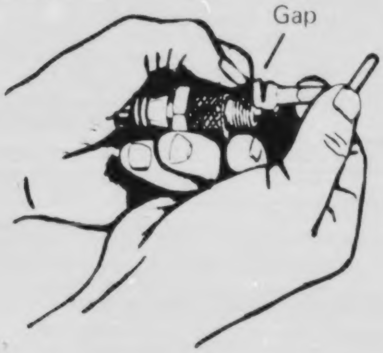
G. File electrodes on plugs until both have flat surfaces (Figure 2)

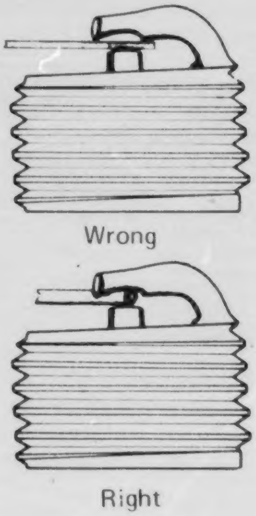
H. Bend the ground electrode back into its original position

I. Determine proper spark gap spacing for your engine (Figure 3)

1. Most plugs set on 0.025"
2. Range from 0.020" to 0.040"

FIGURE 3





SERVICING SMALL ENGINES
UNIT I

JOB SHEET #12--REPLACE IGNITION CONTACT POINTS AND CONDENSER ON INTERNAL MAGNETO

I. Tools and materials

  A. Socket set, 3/8" drive

  B. Combination wrench set

  C. Standard screwdriver

  D. Soft hammer

  E. Flywheel holding tool

  F. Flywheel puller

  G. Fire extinguisher

  H. **Feeler gauge**

II. Procedure

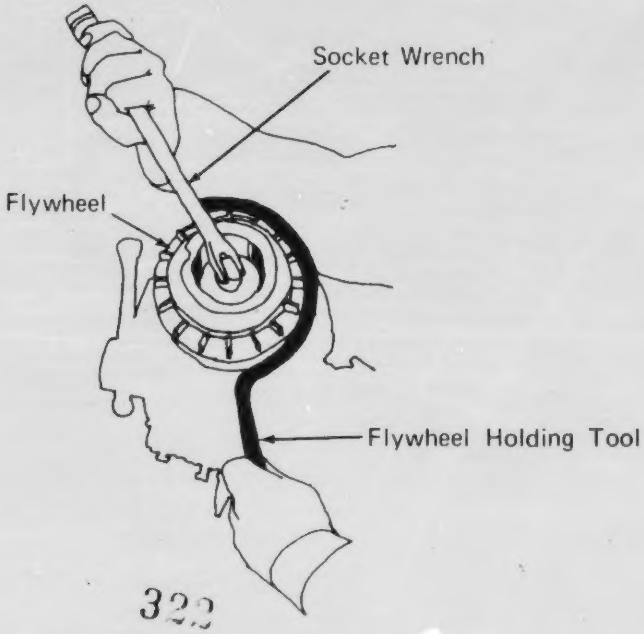
  A. Disconnect spark plug wire

  B. Disconnect fuel line

  C. Remove flywheel shroud and fuel tank; rewind starter

  D. Remove flywheel nut (Figure 1)

FIGURE 1



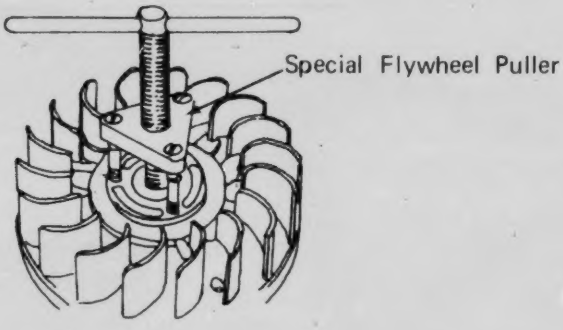
JOB SHEET #12

E. Remove the flywheel by one of these two methods

1. Attach flywheel puller and remove flywheel (Figure 2)

   (NOTE: Care should be taken not to damage the crankshaft threads.)

FIGURE 2


Special Flywheel Puller

2. Remove flywheel from a tapered shaft only (Figure 3)

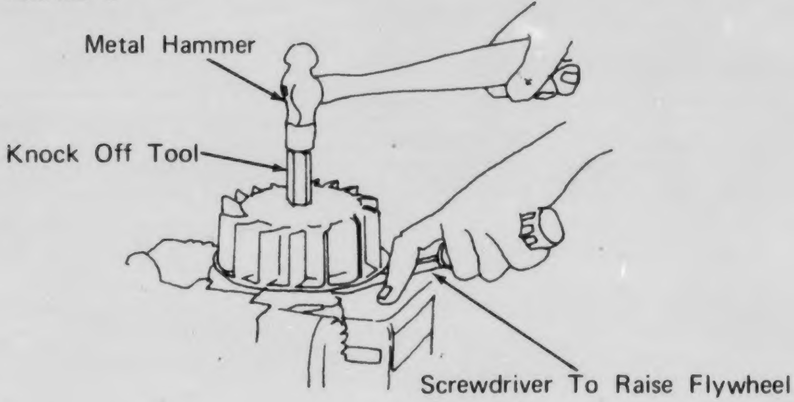
   a. Place knock-off tool on end of crankshaft

   b. Hold pressure on flywheel by hand or pry it

   c. Strike end of knock-off tool with a sharp blow

      (NOTE: Do not strike the knock-off tool more than three to four times because it could knock the magnetism out of the flywheel.)

FIGURE 3


Metal Hammer
Knock Off Tool
Screwdriver To Raise Flywheel

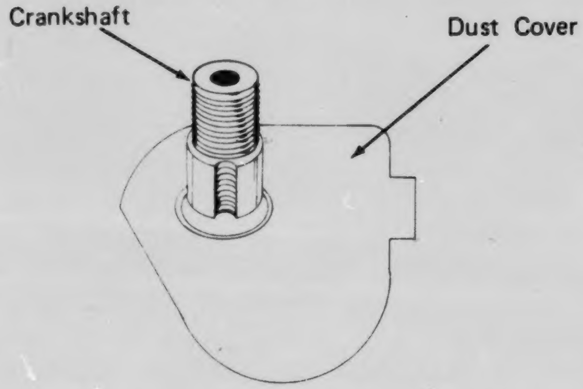
JOB SHEET #12

F. Clean the area of the engine covered by the flywheel

G. Remove the ignition dust cover (Figure 4)

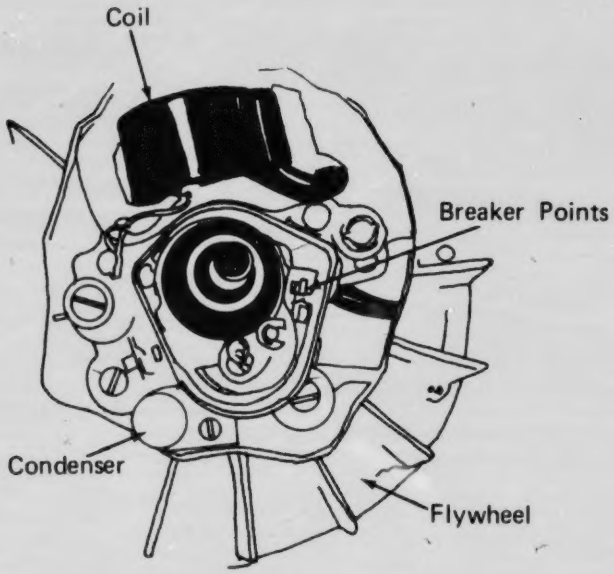
(NOTE: On some models it will be necessary to remove the centrifugal spark advance mechanism before removing the dust cover.)

FIGURE 4


Crankshaft
Dust Cover

H. Remove the points and condenser (Figure 5)

FIGURE 5


Coil
Breaker Points
Condenser
Flywheel

JOB SHEET #12

I. Inspect the crankshaft seal for oil leaks

J. Check for worn crankshaft bearings

K. Inspect the point cam area on the crankshaft

L. Inspect the ignition switch wire for proper insulation and proper routing

(NOTE: Some machinery is equipped with a safety shut-off switch that needs to be inspected for proper operation.)

M. Inspect the magneto coil for

1. Good ground connection
2. Insulation for cracks or overheated spots
3. Spark plug wire insulation and proper routing

N. Inspect the flywheel for

1. Keyway condition (Figure 6)
2. Key condition (Figure 6)

(NOTE: A partially sheared key or enlarged keyway will cause a weak ignition spark. See Figure 7.)

FIGURE 6

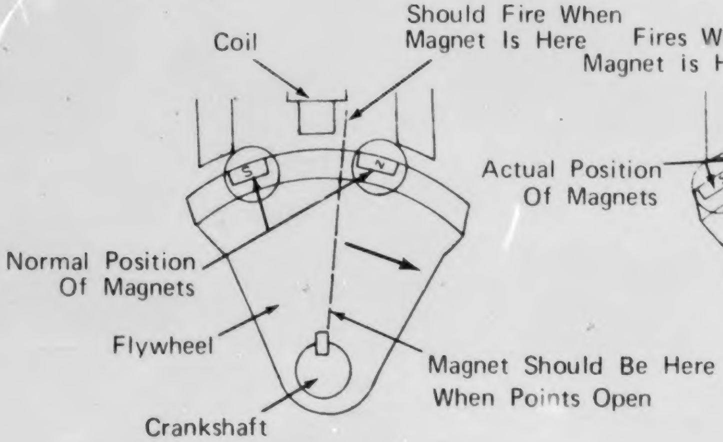
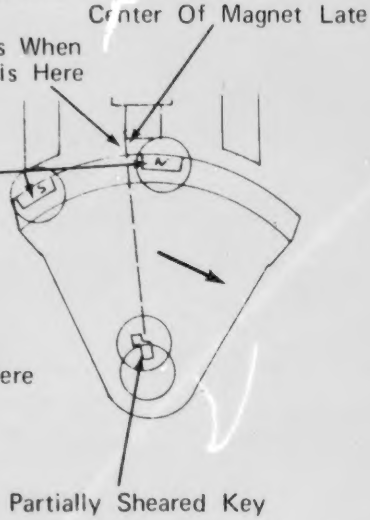

Coil
Should Fire When Magnet Is Here
S
N
Normal Position Of Magnets
Flywheel
Magnet Should Be Here When Points Open
Crankshaft

FIGURE 7


Center Of Magnet Late
Fires When Magnet is Here
Actual Position Of Magnets
S
N
Partially Sheared Key

JOB SHEET #12

   3. Interference with the coil armature
   4. Strong magnetic pull

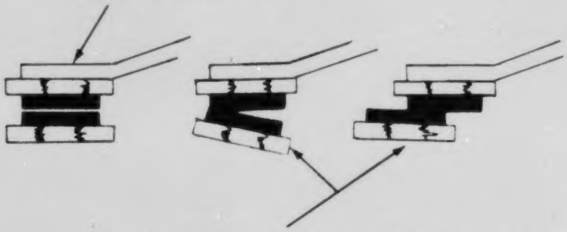
O. Install the ignition points and condenser

P. Lubricate the point rubbing block

Q. Align contact surfaces on points (Figure 8)

FIGURE 8

Breaker Points Should Fit Together Squarely To Keep Down Wear



Partial Contact Causes Arcing And Uneven Wear

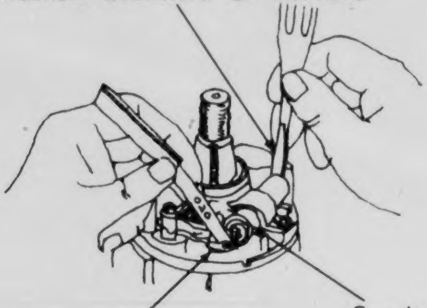
R. Turn the crankshaft in the direction of normal rotation until cam opens breaker points to the widest position

S. Adjust the point gap

   1. Loosen condenser clamp and move condenser to adjust gap (Figure 9)

FIGURE 9

With Screwdriver
Move Condenser Backward Or Forward



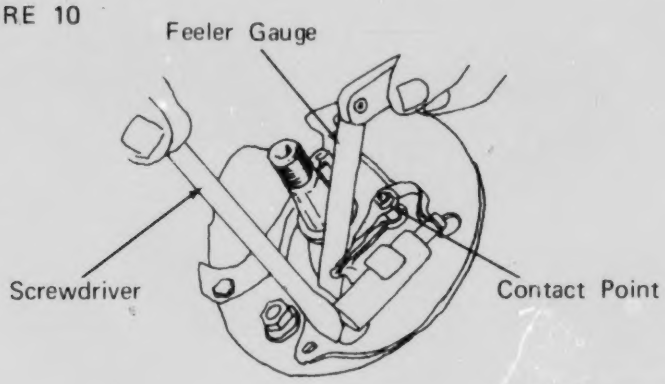
Contact Point Bracket

Condenser

JOB SHEET #12

2. Loosen retaining screw on stationary point just enough to slide point on breaker plate to adjust gap (Figure 10)

FIGURE 10


Feeler Gauge
Screwdriver
Contact Point

T. Rotate the crankshaft four or five turns and watch point for proper operation

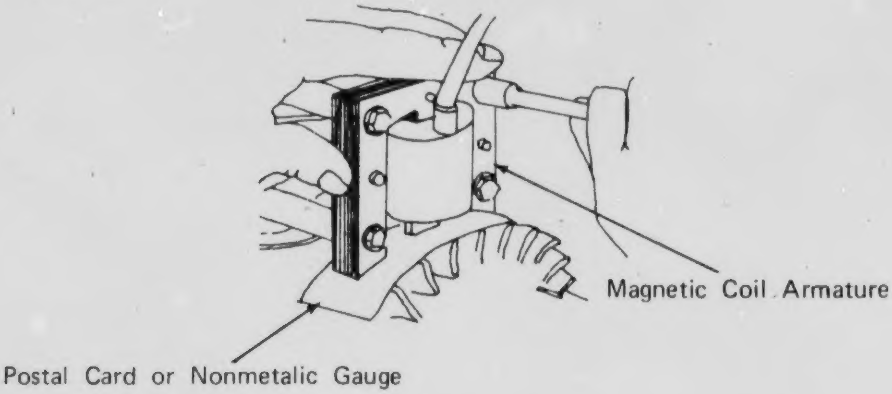
U. Install ignition dust cover and ignition advance mechanism if so equipped

V. Install flywheel and torque the retaining nut

W. Adjust the magneto armature gap to 0.005"-0.010"

(NOTE: A postal card is a good gauge to use for this adjustment. See Figure 11.)

FIGURE 11


Magnetic Coil Armature
Postal Card or Nonmetalic Gauge

JOB SHEET #12

X. Replace flywheel shroud, fuel tank, and rewind starter assembly

Y. Connect fuel line

Z. Connect spark plug wire

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #13--REPLACE IGNITION CONTACT POINTS AND CONDENSER ON EXTERNAL MAGNETO

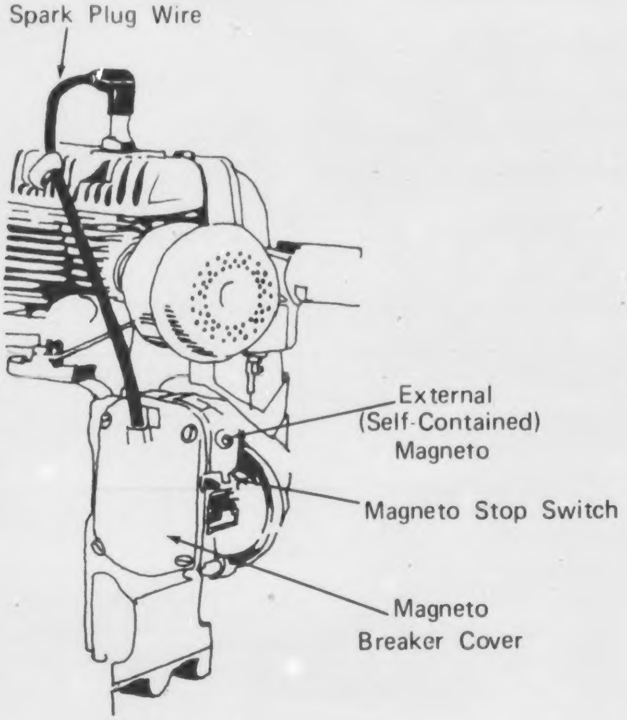
I. Tools and materials

- A. Socket set, 3/8" drive
- B. Combination wrench set
- C. Standard screwdriver
- D. Timing light
- E. Fire extinguisher
- F. Feeler gauge

II. Procedure

A. Remove any equipment or engine accessories necessary to allow easy access to the magneto (Figure 1)

FIGURE 1


Spark Plug Wire
External (Self-Contained) Magneto
Magneto Stop Switch
Magneto Breaker Cover

JOB SHEET #13

B. Clean magneto breaker cover and some working area around it (Figure 1)

C. Remove the breaker cover

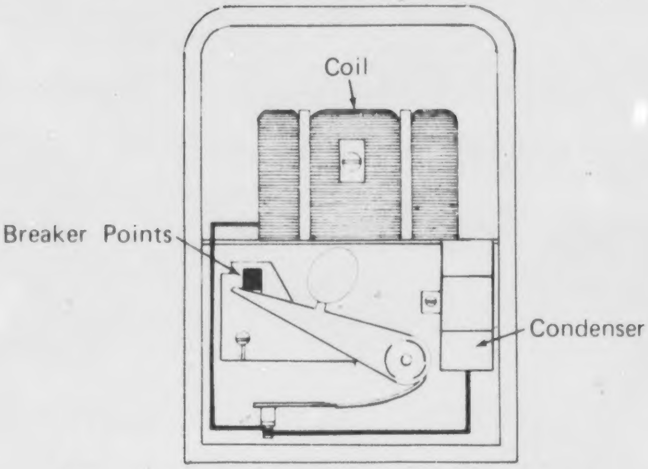
D. Clean and inspect the cover for cracks, spark paths, and a good seal to magneto case

E. Inspect the spark plug wire connections and insulation

(NOTE: Use a continuity light to test wire connections.)

F. Remove breaker points and condenser (Figure 2)

FIGURE 2



G. Clean the inside of the magneto

H. Lubricate the breaker cam

I. Install the new breaker points and condenser (Figure 2)

J. Rotate the engine in the normal direction of operation until the breaker points are open to the widest position

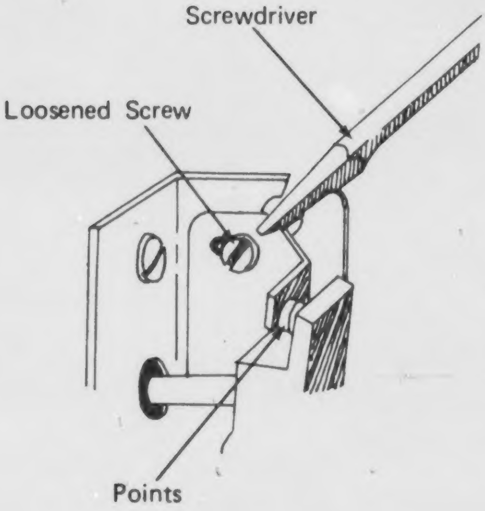
JOB SHEET #13

K. Adjust breaker point gap

1. Loosen the point retaining screw just enough to enable the stationary point to be moved by prying but maintain its position until adjustment is completed

2. Gauge and adjust the distance between the two breaker points with a wire feeler gauge so that the gauge has a very light drag and the movable point does not move when the gauge is pulled out (Figure 3)

FIGURE 3



3. Retighten the retaining screw

4. Rotate the engine several times and recheck the breaker point gap

L. Replace the magneto cover

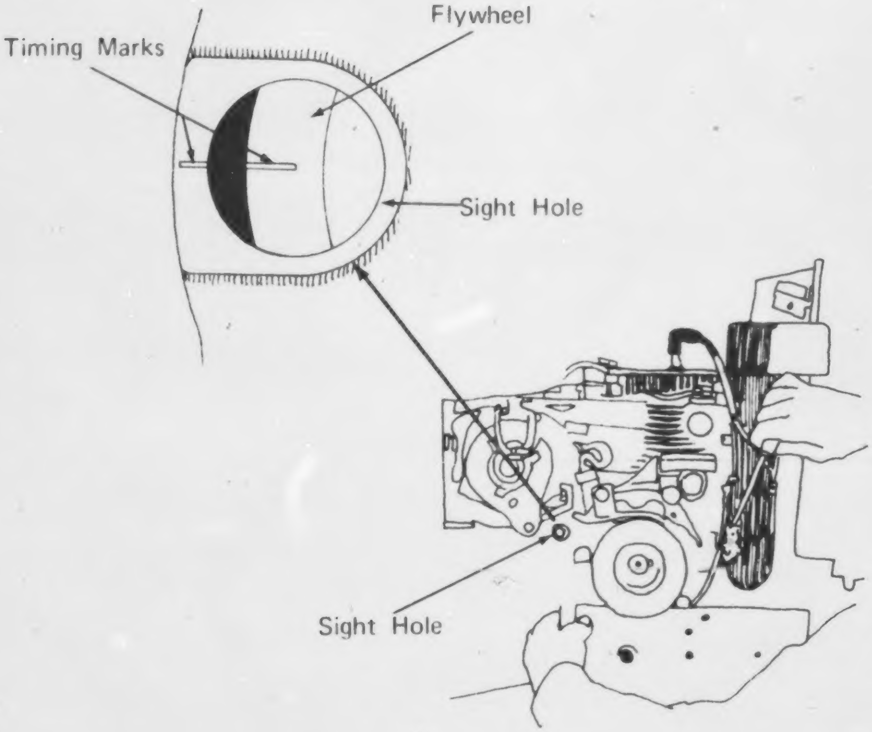
(NOTE: Be sure the cover makes a good seal with the magneto case so it will seal against dirt and moisture.)

JOB SHEET #13

M. Time the magneto to the engine

1. Connect the heavy insulated lead of the timing light in series with the spark plug wire (Figure 4)
2. Connect primary leads to battery posts or to twelve volt supply
3. Locate the timing marks and clean so they can be easily seen (Figure 4)

FIGURE 4

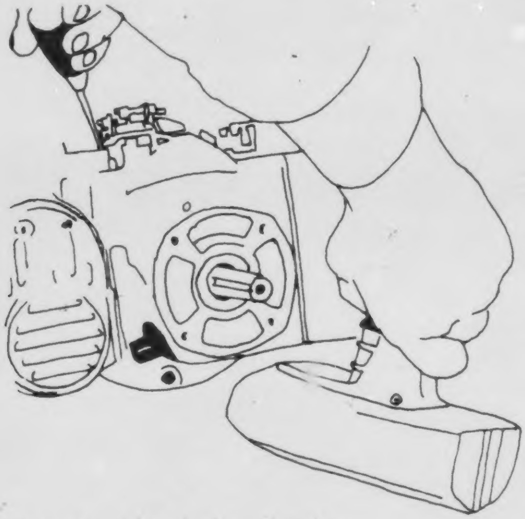

Flywheel
Timing Marks
Sight Hole
Sight Hole

4. Start the engine and adjust the idle to approximately 1,000 rpm

JOB SHEET #13

5. Hold the timing light so that it will flash on the timing marks (Figure 5)

FIGURE 5



6. Loosen the magneto attaching bolts slightly

7. Rotate the magneto case in either direction until the timing marks align and retighten the attaching bolts

   (NOTE: If the timing cannot be set correctly by rotating the magneto it will be necessary to readjust the points until the timing marks align.)

8. Disconnect the timing light

N. Replace any equipment or engine accessories removed to allow access to the magneto

SERVICING SMALL ENGINES
UNIT I

JOB SHEET #14--SERVICE FLOAT TYPE CARBURETOR

I. Tools and materials

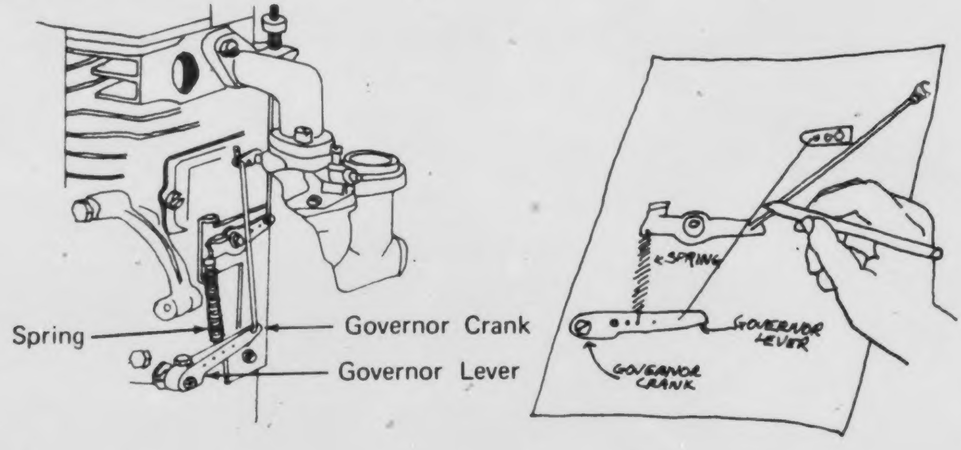
- A. Combination wrench set
- B. Socket set, 3/8" drive
- C. Standard screwdriver set
- D. Phillips screwdriver set
- E. Needle nose pliers
- F. Steel ruler, 6"
- G. Suitable carburetor cleaning fluid
- H. Parts cleaning basket
- I. Fire extinguisher

II. Procedure

- A. Close fuel shut-off valve
- B. Disconnect fuel line
- C. Disconnect throttle and choke cable
- D. Disconnect governor linkage

  (NOTE: It is recommended that you make a sketch of the linkages and their positions to aid reassembly. See Figure 1.)

FIGURE 1

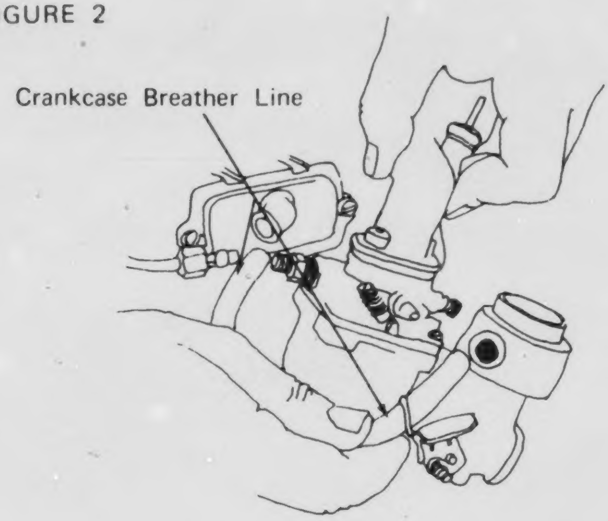

Spring
Governor Crank
Governor Lever
SPRING
GOVERNOR LEVER
GOVERNOR CRANK

JOB SHEET #14

E. Remove the carburetor

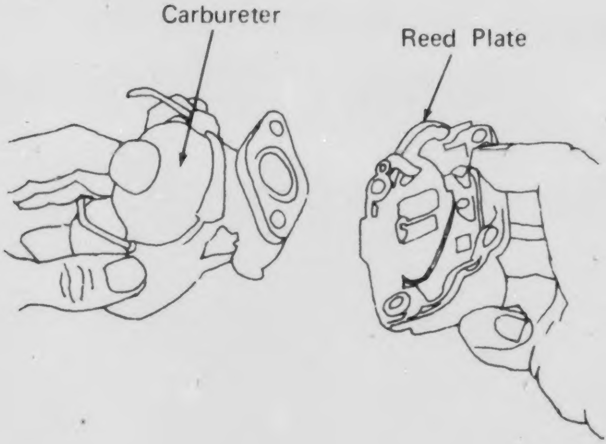
(NOTE: Some models have a breather return hose to disconnect. See Figure 2.)

FIGURE 2


Crankcase Breather Line

F. Remove the intake valve plate from the carburetor on some two-cycle engines (Figure 3)

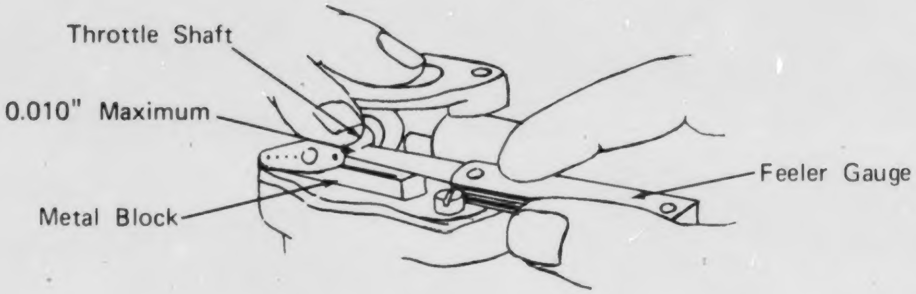
FIGURE 3


Carbureter
Reed Plate

JOB SHEET #14

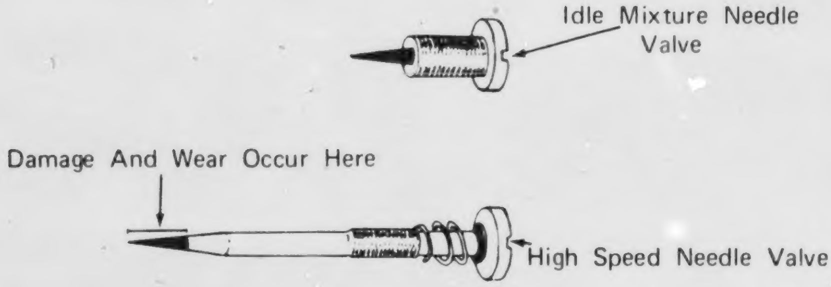
G. Check throttle shaft bushing for wear (Figure 4)

FIGURE 4


Throttle Shaft
0.010" Maximum
Metal Block
Feeler Gauge

H. Remove and check the condition of the high speed and idle speed needle valves (Figure 5)

FIGURE 5

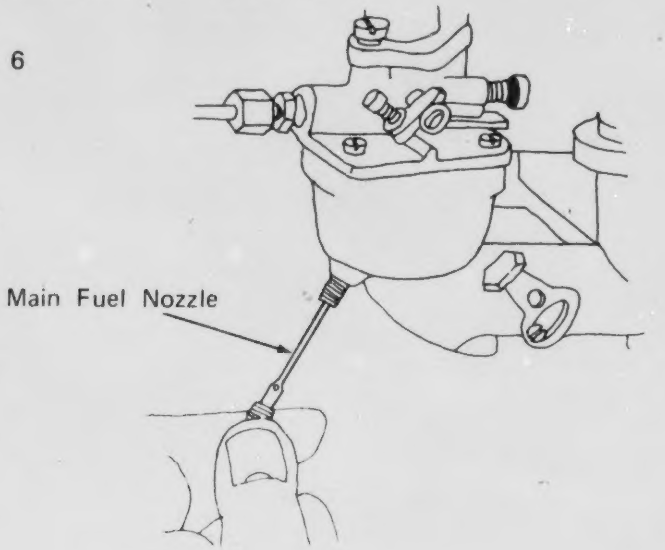

Idle Mixture Needle Valve
Damage And Wear Occur Here
High Speed Needle Valve

JOB SHEET #14

I. Remove the float bowl

(NOTE: On two piece carburetors remove the main fuel nozzle before removing float bowl. See Figure 6.)

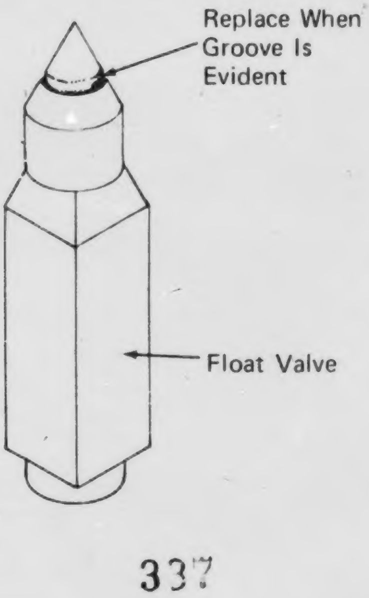
FIGURE 6


Main Fuel Nozzle

J. Remove float hinge pin and remove float

K. Remove float valve and inspect for wear; replace if a groove is worn in the tapered point of the valve (Figure 7)

FIGURE 7

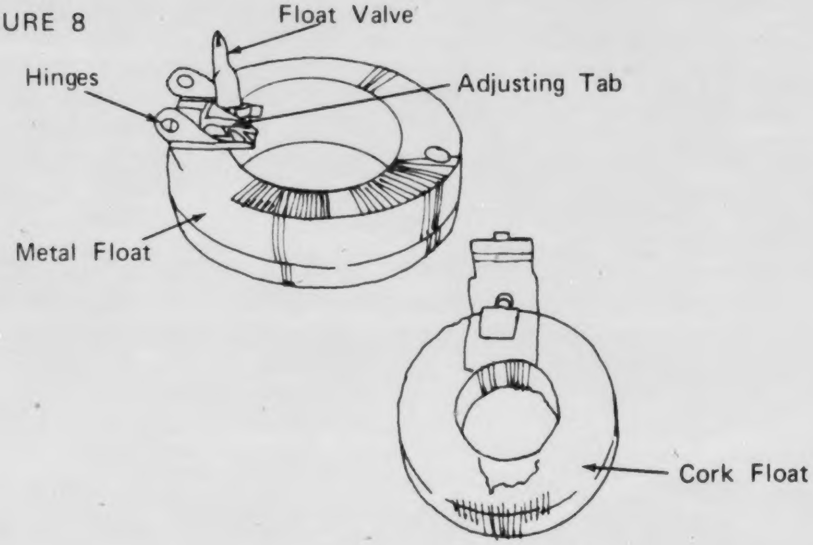

Replace When Groove Is Evident
Float Valve

JOB SHEET #14

L. Inspect the floats for

1. Worn hinges
2. Fuel in metal floats; replace if you feel a liquid inside the float
3. Good varnish coating on cork floats; replace the float if the varnish is peeling or has been punched (Figure 8)

FIGURE 8



M. Remove all gaskets and/or rubber parts on the carburetor

N. Place all the carburetor parts except the gaskets, float, and rubber parts in a cleaner basket

O. Place the basket in the carburetor cleaner and gently move it up and down to circulate the cleaner through the parts; then let it set for approximately one hour

P. Remove the basket from the cleaner

Q. Rinse the parts and basket thoroughly with water

R. Dry the parts, one at a time, with compressed air

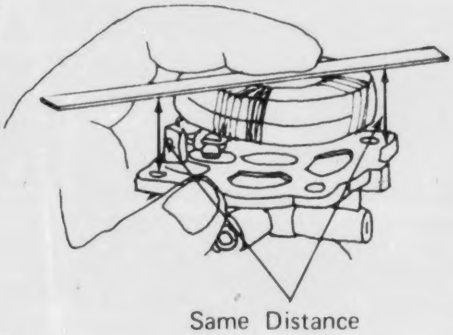
(NOTE: Be sure to blow out all passages in the carburetor body.)

S. Replace float valve and float on the carburetor body

JOB SHEET #14

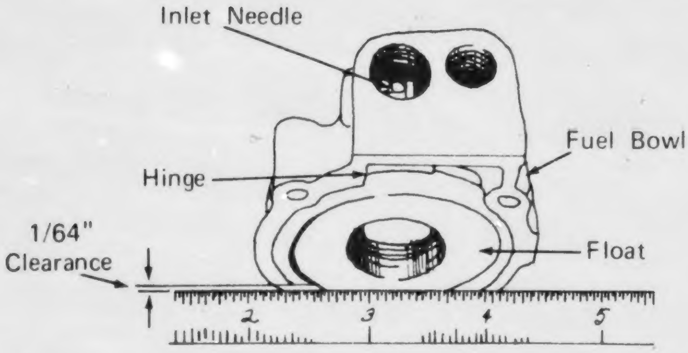
T. Adjust the float level by bending the tab and measuring correct height with a steel ruler (Figure 9)

FIGURE 9


Same Distance

U. Check distance from carburetor to float top for proper height and equal distance on horizontal float (Figure 10)

FIGURE 10

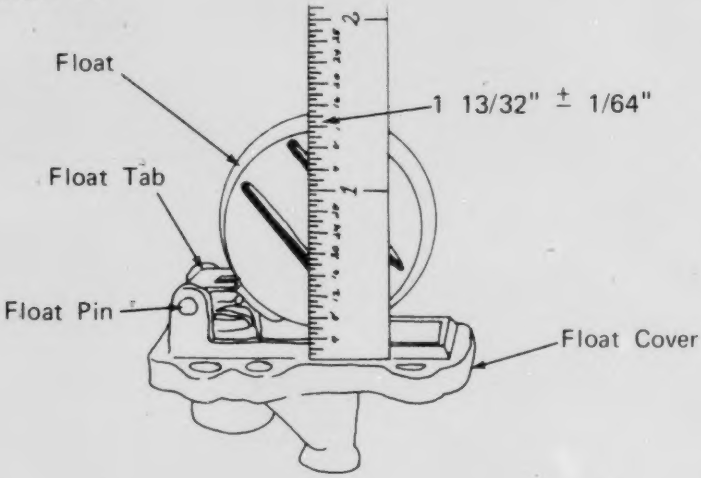

Inlet Needle
Fuel Bowl
Hinge
1/64"
Clearance
Float
2
3
4
5

JOB SHEET #14

V. Check distance on a vertical float from carburetor top to top of float

(NOTE: Float should be true vertical to the carburetor top to prevent interference with float bowl walls. See Figure 11.)

FIGURE 11



W. Check bottom of float for proper clearance in relation to float bowl

X. Install new float bowl gasket and attach bowl to carburetor top

Y. Install idle mixture valve and screw it down until it is lightly seated; then back it out approximately two turns

(NOTE: Install the main fuel nozzle on the two-piece carburetor.)

Z. Install the high speed valve and screw it down until it is lightly seated; then back it out approximately two turns

(NOTE: Steps Y and Z are preliminary adjustments only and will be completed with the engine running.)

AA. Check for free operation of the throttle and choke valve

BB. Install the carburetor on the engine

CC. Reconnect the governor linkage according to the diagram sketched earlier

DD. Reconnect throttle and choke linkage

EE. Reconnect fuel line

FF. Open fuel shut-off valve and watch float bowl area of the carburetor for fuel leaks

(NOTE: Occasionally the float valve will get contamination in it that will keep it from shutting off. In this case, a few light taps on the valve area will release the contamination and solve the problem.)

GG. Start the engine and operate until it is at normal operating temperature

HH. Adjust idle speed

II. Adjust the idle mixture valve to the highest and smoothest rpm at idle speed

(NOTE: It may be necessary to reset the idle speed again.)

JJ. Accelerate the engine up to governor controlled rpm and adjust high speed valve to highest and smoothest rpm

SERVICING SMALL ENGINES
UNIT I

TEST

NAME ______________________________ SCORE ________________

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

    _____a. Device located in the manifold which controls the fuel and air

    _____b. Gate or valve which allows passage of gas or fluid in one direction only; valve which provides a higher fuel-to-air ratio by restricting air inlet

    _____c. Space between the electrodes of a spark plug through which the spark jumps

    _____d. Hammering force on the piston rather than a uniform pushing force

    _____e. Device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

    _____f. Device for automatically mixing fuel in the proper proportion with air to produce a combustible gas

    _____g. Alternator with permanent magnets used to generate current for the ignition in an internal combustion engine

    _____h. Pair of points, one stationary and the other operated by a cam, to make and break the primary ignition circuit; usually made of tungston, platinum, or silver

    _____i. Device for temporarily collecting and storing a surge of electrical current for later discharge

    1. Condenser
    2. Magneto
    3. Air cleaner
    4. Butterfly (throttle) valve
    5. Spark gap
    6. Choke valve
    7. Ignition contact points (breaker points)
    8. Detonation or knock
    9. Carburetor

2. Name four solutions used in cleaning an engine.

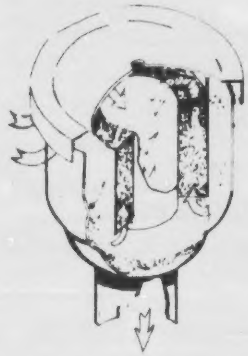
    a. ____

    b. ____

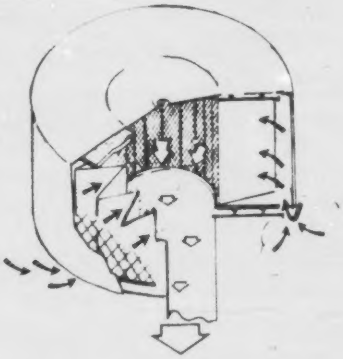
    c. ____

    d. ____

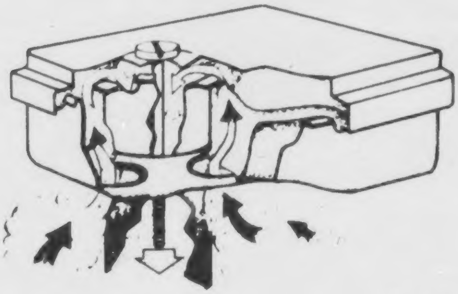
3. Identify the following types of air cleaners by writing the appropriate names in the blanks provided.



a. ______________________

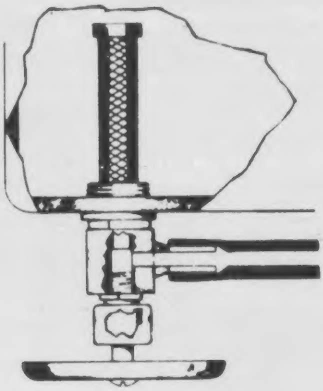


b. ______________________

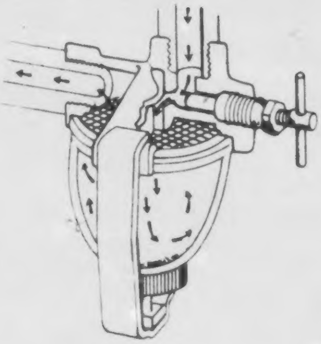


c. ______________________

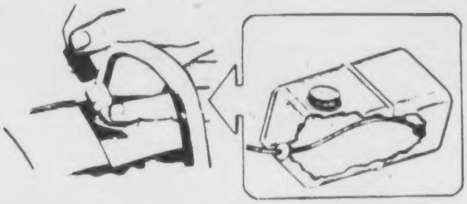
4. Identify the following types of fuel filters.



a.____

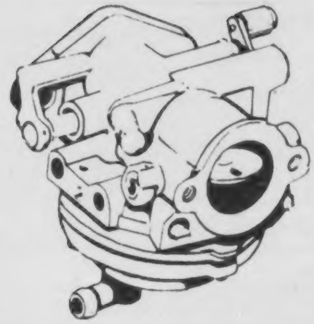


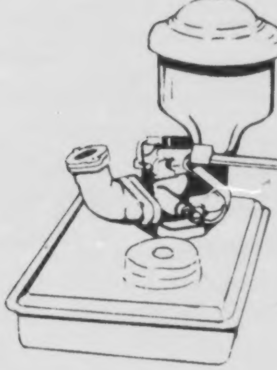
b.____



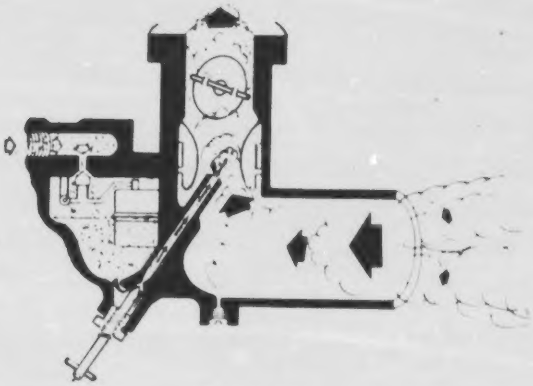
c.____

5. Identify the following types of carburetors.



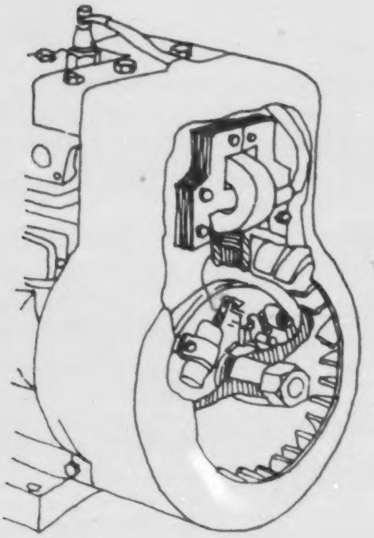


a. ______________________________ b. ______________________________

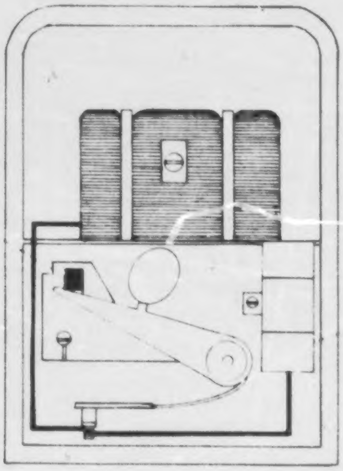


c. ______________________________

6. Identify the following types of magnetos.



a. ____



b. ____

7. Demonstrate the ability to:
   a. Clean and inspect crankcase and accessories.
   b. Clean and inspect cooling system.
   c. Service oil-bath air cleaner.
   d. Service oil-filtered air cleaner.
   e. Service dry-filter air cleaner.
   f. Service sediment bowl fuel strainer.
   g. Service screen type fuel strainer.
   h. Service crankcase breather.
   i. Change crankcase oil.
   j. Check spark plug for proper operation.
   k. Clean and service spark plugs.
   l. Replace ignition contact points and condenser on internal magneto.
   m. Replace ignition contact points and condenser on external magneto.
   n. Service float type carburetor.

   (NOTE: If the above activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

SERVICING SMALL ENGINES
UNIT I

ANSWERS TO TEST

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

__4__ a. Device located in the manifold which controls the fuel and air

__6__ b. Gate or valve which allows passage of gas or fluid in one direction only; valve which provides a higher fuel-to-air ratio by restricting air inlet

__5__ c. Space between the electrodes of a spark plug through which the spark jumps

__8__ d. Hammering force on the piston rather than a uniform pushing force

__3__ e. Device for filtering, cleaning, and removing dust from the air admitted to a unit, such as an engine

__9__ f. Device for automatically mixing fuel in the proper proportion with air to produce a combustible gas

__2__ g. Alternator with permanent magnets used to generate current for the ignition in an internal combustion engine

__7__ h. Pair of points, one stationary and the other operated by a cam, to make and break the primary ignition circuit; usually made of tungston, platinum, or silver

__1__ i. Device for temporarily collecting and storing a surge of electrical current for later discharge

1. Condenser
2. Magneto
3. Air cleaner
4. Butterfly (throttle) valve
5. Spark gap
6. Choke valve
7. Ignition contact points (breaker points)
8. Detonation or knock
9. Carburetor

2. Name four solutions used in cleaning an engine.

   (NOTE: Any four of the following are acceptable.)

   a. Commercial solvent called *degreaser*

   b. Petroleum solvents

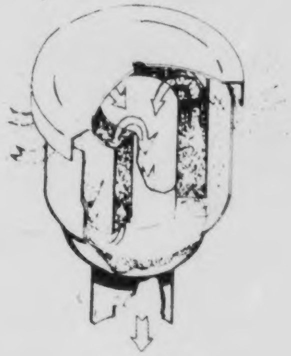
      1) Kerosene

      2) Diesel fuel

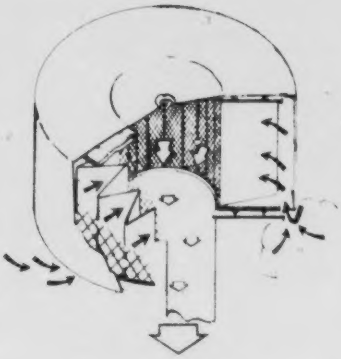
   c. Live steam

   d. Detergent solvent (car wash)

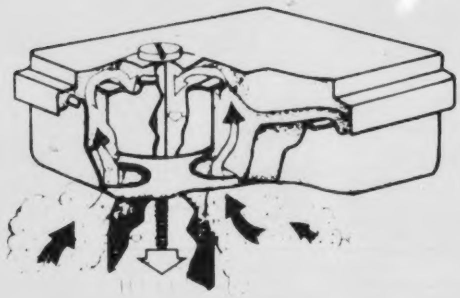
3. Identify the following types of air cleaners by writing the appropriate names in the blanks provided.



a. Oil-bath

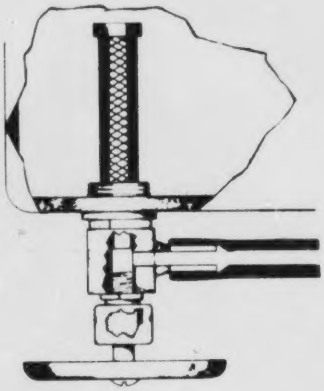


b. Dry-filter

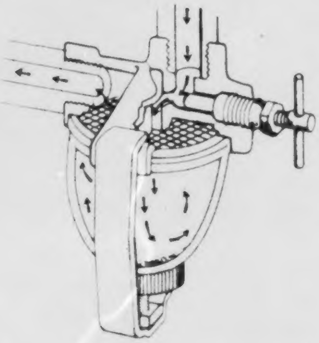


c. Oiled-filter

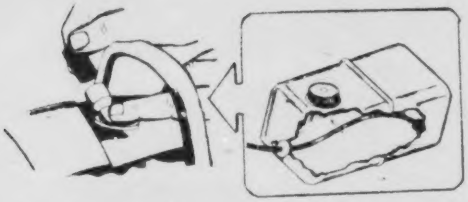
4. Identify the following types of fuel filters.



a. Screen in fuel tank

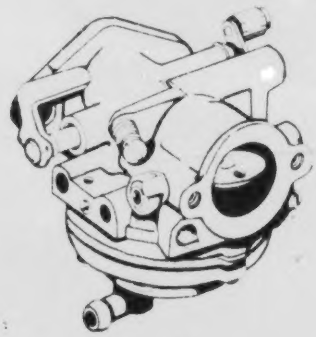


b. Combination screen and sediment bowl

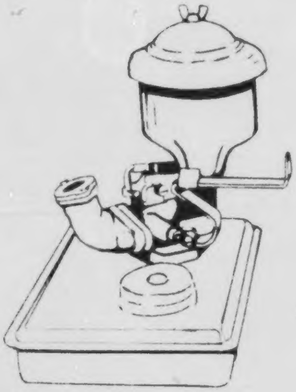


c. Strainer on fuel pick-up hose

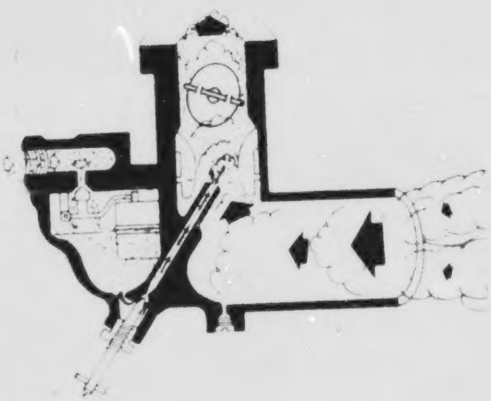
5. Identify the following types of carburetors.



a. Diaphragm

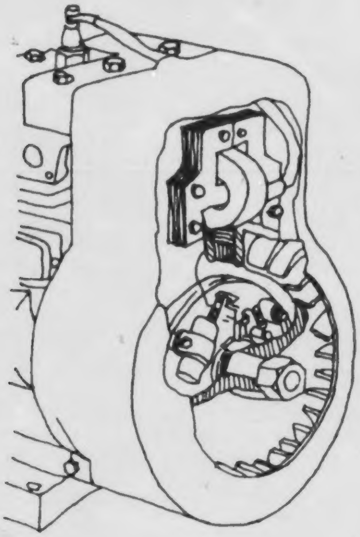


b. Suction-lift

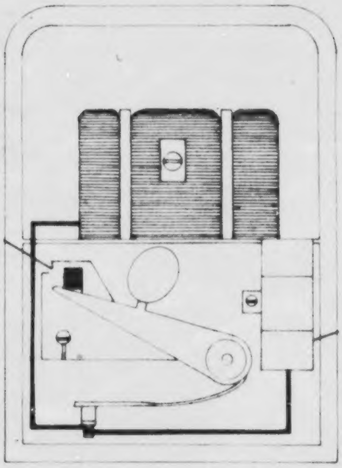


c. Float

6. Identify the following types of magnetos.



a. Internal (flywheel) magneto



b. External magneto

7. Demonstrate the ability to:

   a. Clean and inspect crankcase and accessories.

   b. Clean and inspect cooling system.

   c. Service oil-bath air cleaner.

   d. Service oil-filtered air cleaner.

   e. Service dry-filter air cleaner.

   f. Service sediment bowl fuel strainer.

   g. Service screen type fuel strainer.

   h. Service crankcase breather.

   i. Change crankcase oil.

   j. Check spark plug for proper operation.

   k. Clean and service spark plugs.

   l. Replace ignition contact points and condenser on internal magneto.

   m. Replace ignition contact points and condenser on external magneto.

   n. Service float type carburetor.

   (NOTE: The performance activities should be evaluated to the satisfaction of the instructor.)

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify parts of an engine and identify special tools needed for engine overhaul. The student should be able to list uses of small gasoline engines, read a nameplate, describe differences between two-stroke and four-stroke cycle engines, and read a micrometer. The student should be able to complete an engine inspection chart and disassemble, inspect, replace rings, reface valves and valve seats, and reassemble small gasoline engines. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

1. Match terms associated with overhauling small gasoline engines to the correct definitions.
2. List systems found in a small gasoline engine.
3. Identify parts of a small horizontal shaft gasoline engine.
4. Identify special tools needed in overhauling small gasoline engines.
5. List uses for small gasoline engines.
6. Identify the basic operating positions of the small gasoline engine.
7. List items found on an engine nameplate.
8. State the importance of being able to read an engine nameplate.
9. Describe differences between two-stroke and four-stroke cycle engines.
10. Identify the strokes of a four-stroke cycle engine and of a two-stroke cycle engine.
11. Identify parts of a valve.
12. Identify kinds of rings.
13. Match each kind of ring to its specific purpose.
14. Identify parts of a plain micrometer.
15. Read the plain micrometer.
16. Complete engine inspection chart.

17. Demonstrate the ability to:
    - a. Disassemble, inspect, and reassemble a four-stroke cycle engine.
    - b. Disassemble, inspect, and reassemble a two-stroke cycle engine.
    - c. Reface valves and valve seats.
    - d. Replace rings.

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information, assignment, and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate activities outlined on job sheets.

      (NOTE: Provide each student with the opportunity to complete additional overhaul of engines.)

   G. Give test.

II. Unit references:

   A. Turner, Howard J. *Small Engines: Care, Operation, Maintenance, and Repair.* Vol. I. Athens, Georgia: American Association for Vocational Instructional Materials, 1971.

   B. Turner, Howard J. *Small Engines: Maintenance and Repair.* Vol. II. Athens, Georgia: American Association for Vocational Instructional Materials, 1974.

   C. *Briggs and Stratton Repair Instructions III.* Milwaukee, Wisconsin: Briggs and Stratton Corporation, 1964.

   D. *General Theories of Operation.* Milwaukee, Wisconsin: Briggs and Stratton Corporation, 1964.

   E. Armstrong, Ivan J. *Auto Mechanics.* Vol. I. Stillwater: Oklahoma State Department of Vocational and Technical Education, 1977.

   F. *Small Engine Service Manual.* 11th ed. Kansas City: Technical Publication Division, Intertec Publishing Corporation, 1976.

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Camshaft--Shaft containing lobes or cams to operate the engine's valves

B. Carburetor--Device for automatically mixing fuel in the proper proportions with air to produce a combustible gas

C. Combustion--Burning process

D. Combustion chamber--Area of the cylinder above the piston with the piston at top dead center

E. Compression--Reduction in volume of fuel-air mixture within the cylinder

F. Condenser--Device for temporarily collecting and storing an overflow of electrical current for later discharge

G. Conductor--Material along or through which electricity will flow with slight resistance

H. Connecting rod--Rod that connects the piston to the crankshaft

I. Crankcase--Housing in which the crankshaft and many other parts of the engine operate

J. Crankshaft--Main shaft of the engine which, in conjunction with the connecting rods, changes the reciprocating motion of the pistons into rotary motion

K. Cylinder--Hole in engine block which receives a piston; sometimes referred to as *bore* or *barrel*

L. Cylinder block--Largest single piece of an engine; basis or main mass of metal in which the cylinders are bored or placed

M. Cylinder head--Detachable portion of an engine fastened securely to the cylinder block which contains all or a portion of the combustion chamber

N. Exhaust pipe--Pipe connecting the engine to the muffler to conduct the exhaust gases away from the engine

O. Exhaust valve--Device which permits the spent fuel-air mixture to leave the combustion chamber

INFORMATION SHEET

P. Gasket--Anything used as a packing, such as a nonmetallic substance, placed between two metal surfaces to act as a seal

Q. Governor--Control device used to regulate engine speed

R. Ignition system--Means for igniting the fuel in the combustion chamber; includes spark plugs, wires, ignition coil, points, condenser, and source of electrical current

S. Intake valve--Valve which permits the fuel-air mixture to enter the combustion chamber or cylinder and then seals the exit

T. Piston--Cylindrical part closed at one end which is connected to the crankshaft by the connecting rod

U. Piston head--Part of the piston above the rings

V. Piston pin--Pin that goes through the small end of the connecting rod which also passes through the piston walls; also known as *wrist pin*

W. Piston ring--Expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fuel-air mixture past the piston

X. Score--Scratch, ridge, or groove marring a finished surface

Y. Spark--Electrical current possessing sufficient pressure to jump through the air from one conductor to another

Z. Spark gap--Space between the electrodes of a spark plug through which the spark jumps

AA. Spark plug--Device inserted into the combustion chamber of an engine to produce the spark to ignite the compressed fuel-air mixture

BB. Stroke--Distance piston travels inside cylinder

II. Systems in a small gasoline engine

A. Fuel

B. Ignition

C. Lubrication

D. Starting

(NOTE: Some small gasoline engines have an electrical starting system while others have only a manual starting system.)

E. Cooling

INFORMATION SHEET

III. Parts of a small gasoline engine (Transparencies 1 and 2)

   A. Engine block
   B. Piston
   C. Connecting rod
   D. Crankshaft
   E. Camshaft
   F. Push rod or tappet
   G. Valve
   H. Carburetor
   I. Muffler
   J. Cylinder head
   K. Valve guide
   L. Valve spring
   M. Oil fill plug
   N. Crankcase
   O. Piston rings
   P. Cylinder
   Q. Piston pin
   R. Flywheel shroud
   S. Spark plug
   T. Plug wire
   U. Fuel tank

IV. Special tools (Transparencies 3 and 4)

   A. Valve spring compressor
   B. Micrometer
   C. Valve seat refacer

INFORMATION SHEET

D. Valve seat cutter

E. Small hole gauge

F. Hone

G. Boring tool

H. Ring expander

I. Ring compressor

J. Flywheel holder

K. Reamer

L. Starter clutch wrench

V. Uses for small gasoline engines

(NOTE: Those marked with an * are common uses.)

A. Post hole digger

B. Irrigation pump

C. Chain saw*

D. Small tractor

E. Conveyor

F. Motorcycle*

G. Snow blower

H. Rotary tiller*

I. Brush cutter

J. Lawn mower*

K. Lawn edger

L. Outboard motor

M. Air compressor

N. Sprayer*

O. Generator

P. Concrete vibrator

Q. Concrete surfacer

INFORMATION SHEET

VI. Basic operating positions of small gasoline engines (Transparency 5)

A. Vertical crankshaft

B. Horizontal crankshaft

C. Multiposition crankshaft

Example: Chain saw

VII. Items found on an engine nameplate (Transparency 6, Assignment Sheet #1)

A. Make of engine

B. Model number or name of engine

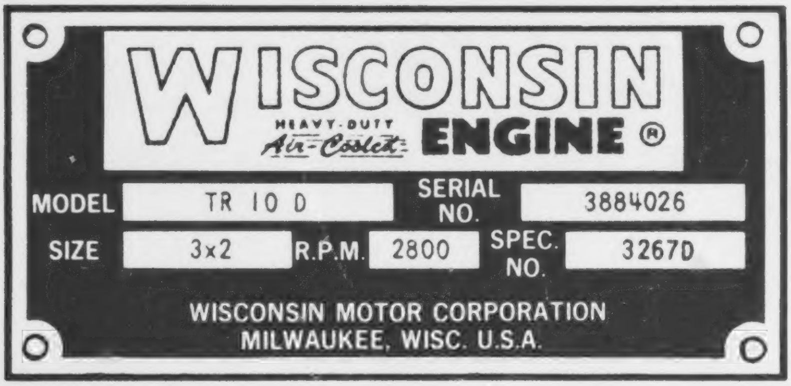
C. Serial number

D. Type number

E. Specification number

F. Size

G. RPM


WISCONSIN
HEAVY-DUTY
Air-Cooled
ENGINE ®
MODEL
TR 10 D
SERIAL NO.
3884026
SIZE
3x2
R.P.M.
2800
SPEC. NO.
3267D
WISCONSIN MOTOR CORPORATION
MILWAUKEE, WISC. U.S.A.

VIII. Importance of reading engine nameplate--Provides information for replacement parts or service

IX. Differences between two-stroke and four-stroke cycle engines

A. Number of power strokes per crankshaft revolution

B. Method of getting fuel-air mixture into combustion chamber

C. Method of exhaust

D. Method of lubricating the internal parts

INFORMATION SHEET

X. Strokes of a four-stroke cycle engine and two-stroke cycle engine (Transparencies 7 and 8)

  A. Four-stroke

    1. Intake

    2. Compression

    3. Power

    4. Exhaust

  B. Two-stroke

    1. Intake-Compression

    2. Power-Exhaust

XI. Parts of a valve

  A. Head

  B. Face

  C. Seat

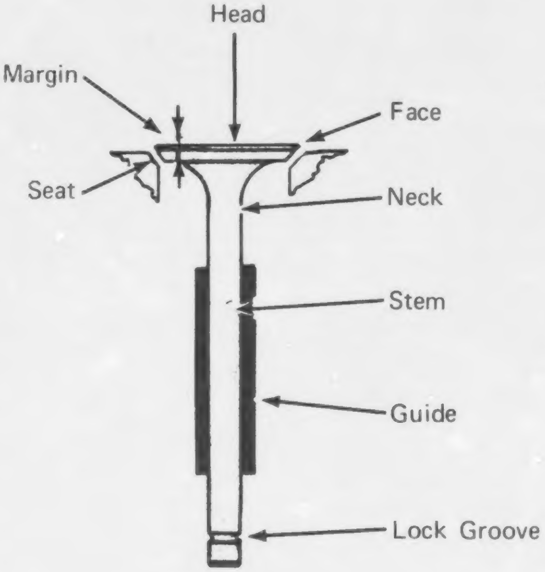
  D. Margin

  E. Neck

  F. Stem

  G. Guide

  H. Lock groove


Head
Margin
Face
Seat
Neck
Stem
Guide
Lock Groove

INFORMATION SHEET

XII. Kinds of rings (Transparency 9)

- A. Compression rings
- B. Oil scraper rings
- C. Oil control rings

XIII. Purposes of rings

- A. Compression rings--Make a tight seal against cylinder wall
- B. Oil scraper rings--Wipe excess oil off cylinder wall as piston moves down

  (NOTE: This prevents the oil from bypassing the ring, entering the combustion chamber, and being burned.)
- C. Oil control rings--Regulate the amount of oil going to the compression rings and cylinder wall

XIV. Parts of a plain micrometer (Transparency 10)

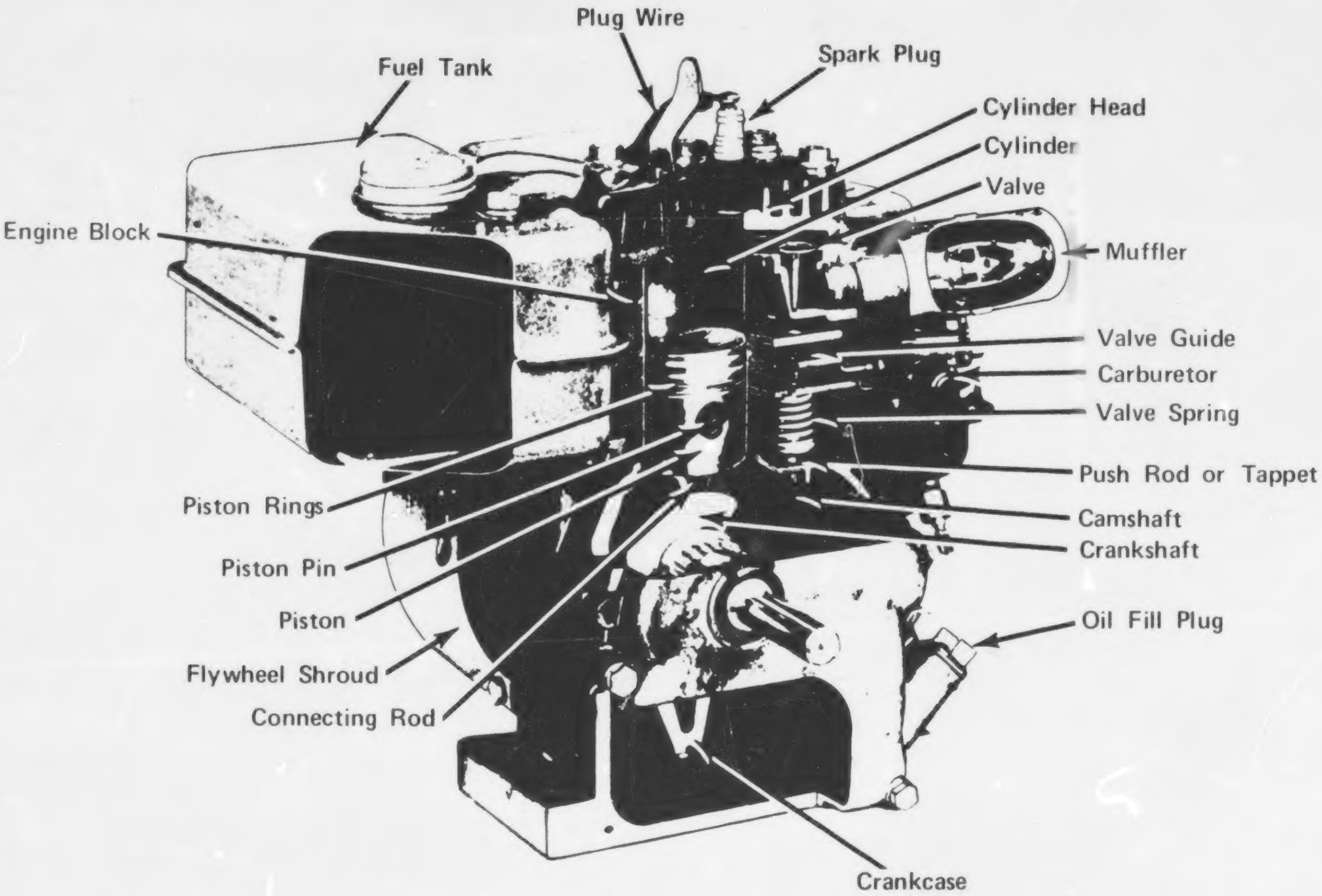
- A. Anvil
- B. Spindle
- C. Lock
- D. Sleeve
- E. Ratchet stop
- F. Thimble
- G. Frame

XV. Read a micrometer (Transparencies 11 and 12)

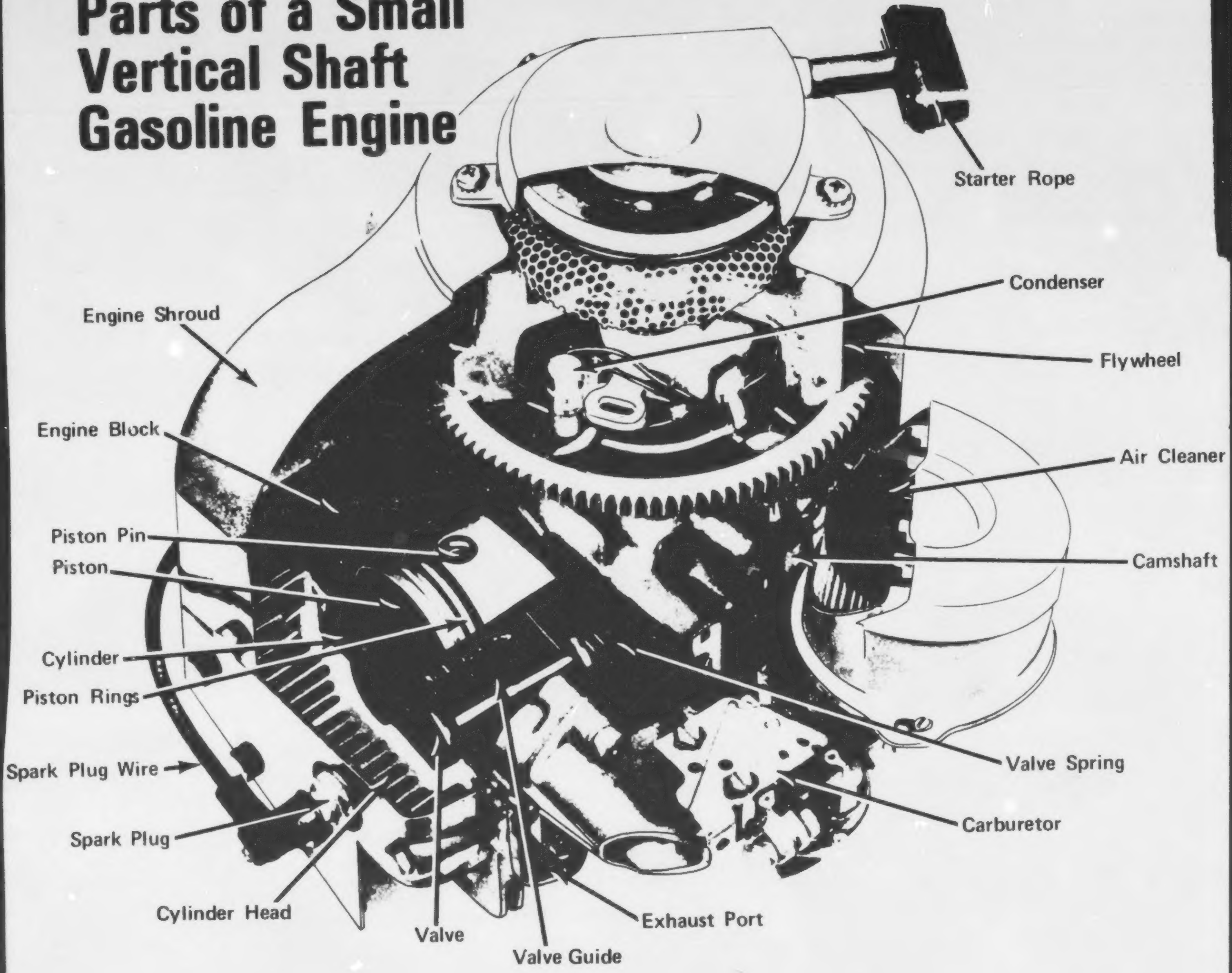
- A. Each numbered graduation on the sleeve represents one hundred thousandths of an inch (0.100")
- B. Each small graduation on the sleeve between the numbered graduations represents twenty-five thousandths of an inch (0.025")
- C. Each graduation found on the thimble represents one thousandth of an inch (0.001")
- D. Total reading is found by adding the three values

Example:	0.300	Number on the sleeve
	0.025	Small graduations on the sleeve
	0.015	Graduations on the thimble
	0.340	Plain micrometer reading

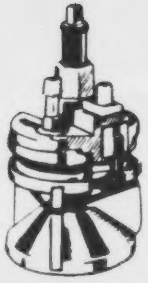
Parts of a Small Horizontal Shaft Gasoline Engine


Plug Wire
Spark Plug
Fuel Tank
Cylinder Head
Cylinder
Valve
Engine Block
Muffler
Valve Guide
Carburetor
Valve Spring
Push Rod or Tappet
Piston Rings
Camshaft
Crankshaft
Piston Pin
Piston
Oil Fill Plug
Flywheel Shroud
Connecting Rod
Crankcase

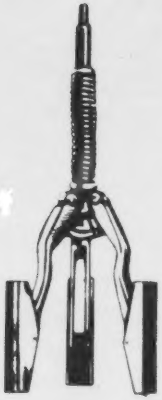
Parts of a Small Vertical Shaft Gasoline Engine


Starter Rope
Condenser
Engine Shroud
Flywheel
Engine Block
Air Cleaner
Piston Pin
Camshaft
Piston
Cylinder
Piston Rings
Spark Plug Wire
Valve Spring
Carburetor
Spark Plug
Cylinder Head
Exhaust Port
Valve
Valve Guide

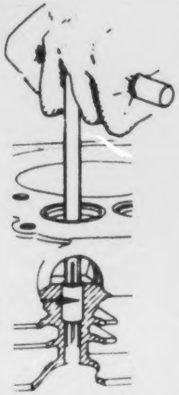
Special Tools



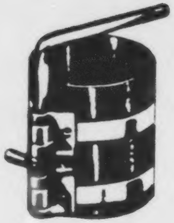
Ridge Reamer



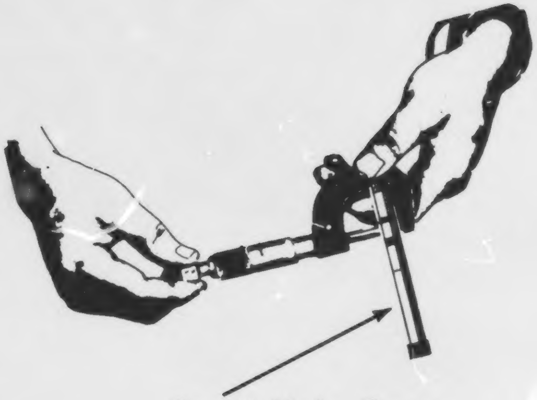
Hone



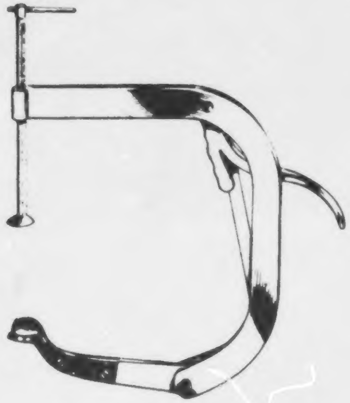
Valve Guide Reamer



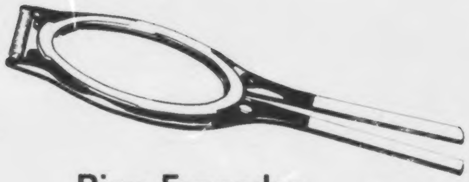
Ring Compressor



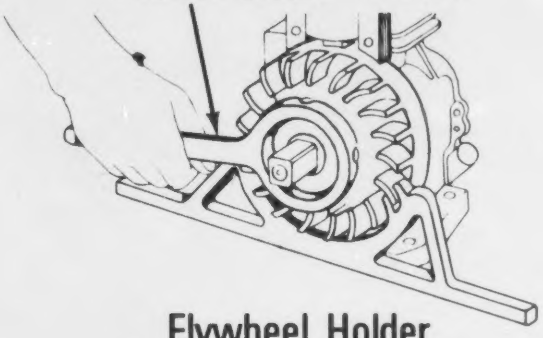
Small Hole Guage



Valve Spring Compressor



Ring Expander

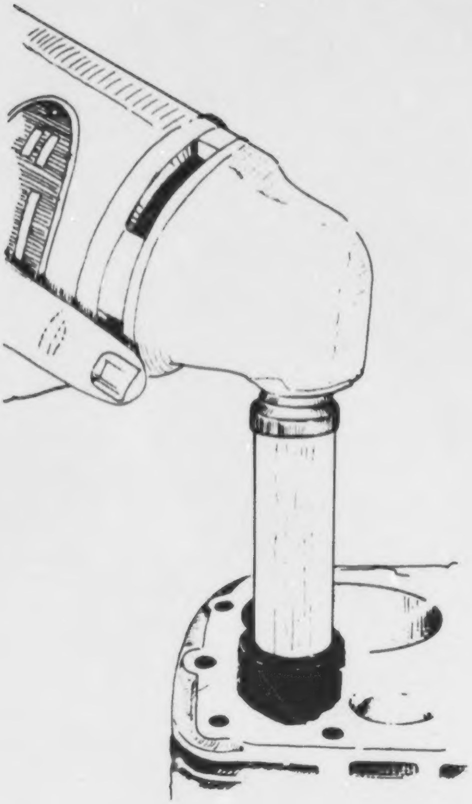


Starter Clutch Wrench

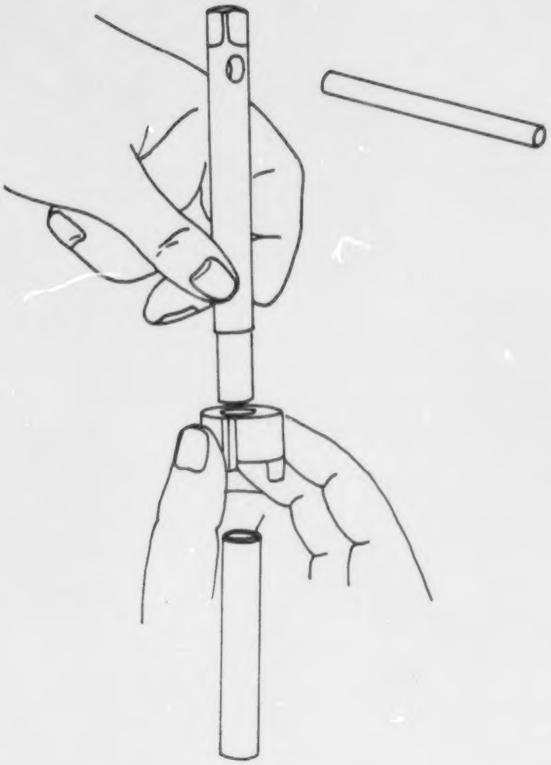
Flywheel Holder

Special Tools

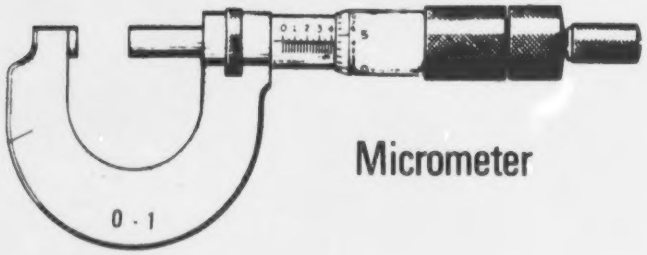
(Continued)



Valve Seat Refacer

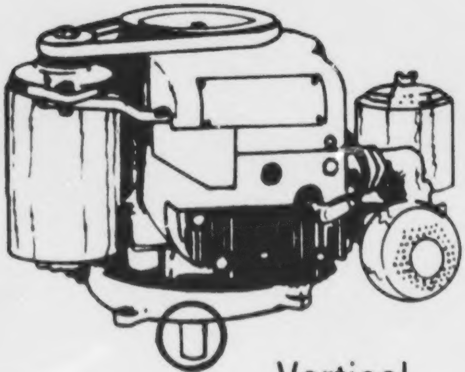


Valve Seat Cutter

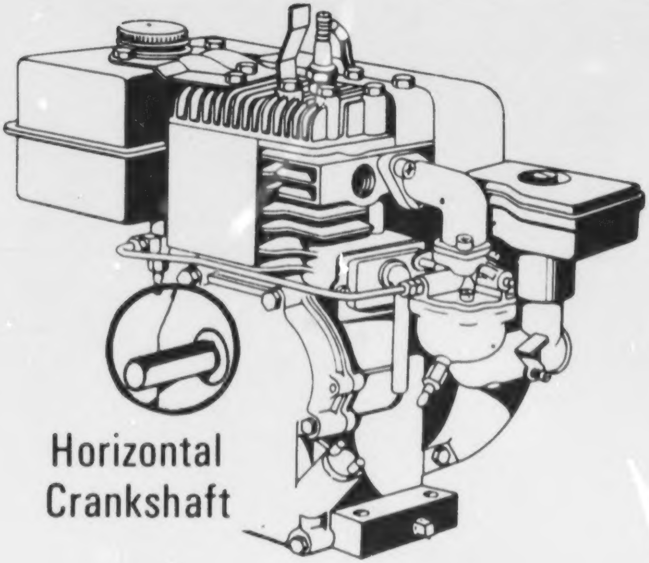


Micrometer

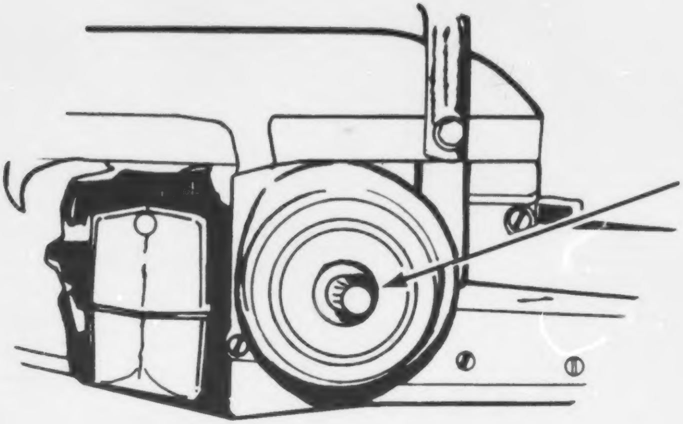
Engine Operating Positions



Vertical Crankshaft

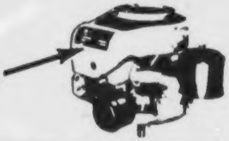


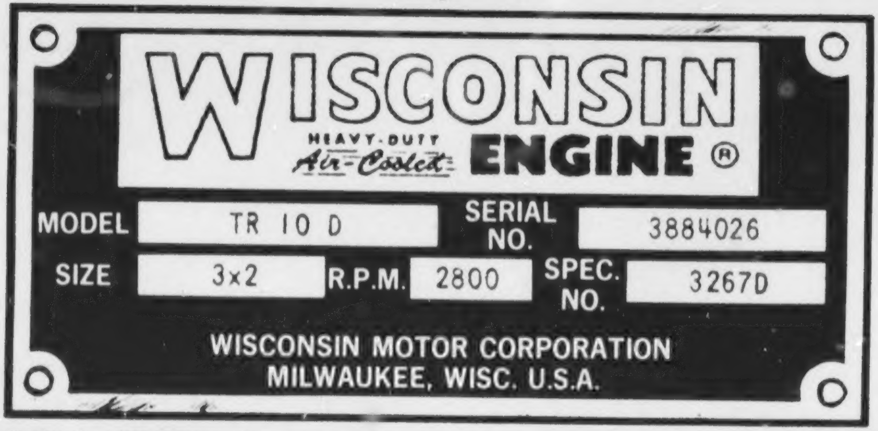
Horizontal Crankshaft



Multiposition Crankshaft

Nameplate Information





WISCONSIN HEAVY-DUTY Air-Cooled ENGINE ®

MODEL TR 10 D

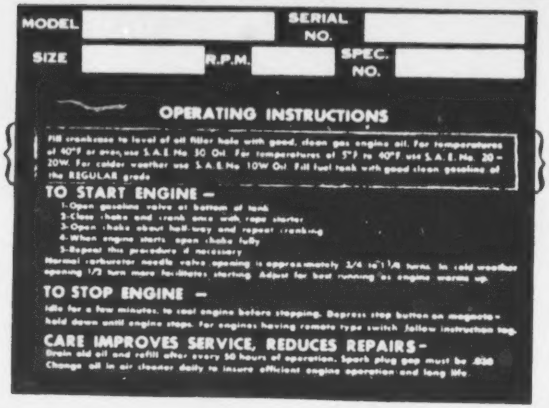
SERIAL NO. 3884026

SIZE 3x2

R.P.M. 2800

SPEC. NO. 3267D

WISCONSIN MOTOR CORPORATION
MILWAUKEE, WISC. U.S.A.



MODEL

SERIAL NO.

SIZE

R.P.M.

SPEC. NO.

OPERATING INSTRUCTIONS

Fill crankcase to level of oil filler hole with good, clean gas engine oil. For temperatures of 40°F or over, use S.A.E. No. 30 Oil. For temperatures of 5°F to 40°F use S.A.E. No. 20-20W. For colder weather use S.A.E. No. 10W Oil. Fill fuel tank with good clean gasoline of the REGULAR grade

TO START ENGINE —

1-Open gasoline valve at bottom of tank
2-Close choke and crank once with rope starter
3-Open choke about half-way and repeat cranking
4-When engine starts open choke fully
5-Repeat this procedure if necessary

Normal carburetor needle valve opening is approximately 3/4 to 1 1/4 turns. In cold weather opening 1/2 turn more facilitates starting. Adjust for best running as engine warms up.

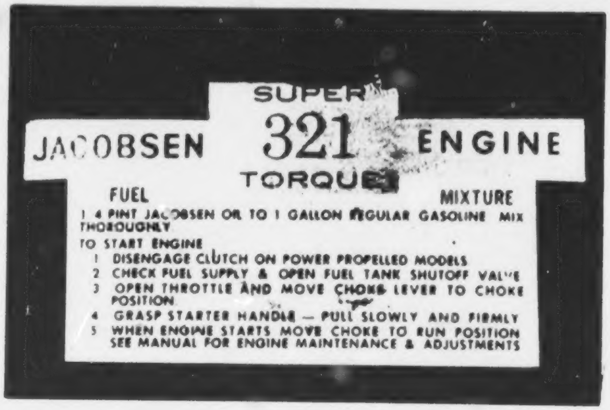
TO STOP ENGINE —

Idle for a few minutes, to cool engine before stopping. Depress stop button on magneto - hold down until engine stops. For engines having remote type switch follow instruction tag.

CARE IMPROVES SERVICE, REDUCES REPAIRS —

Drain old oil and refill after every 50 hours of operation. Spark plug gap must be .030 Change oil in air cleaner daily to insure efficient engine operation and long life.

4-Cycle



SUPER

JACOBSEN 321 ENGINE

TORQUE

FUEL MIXTURE

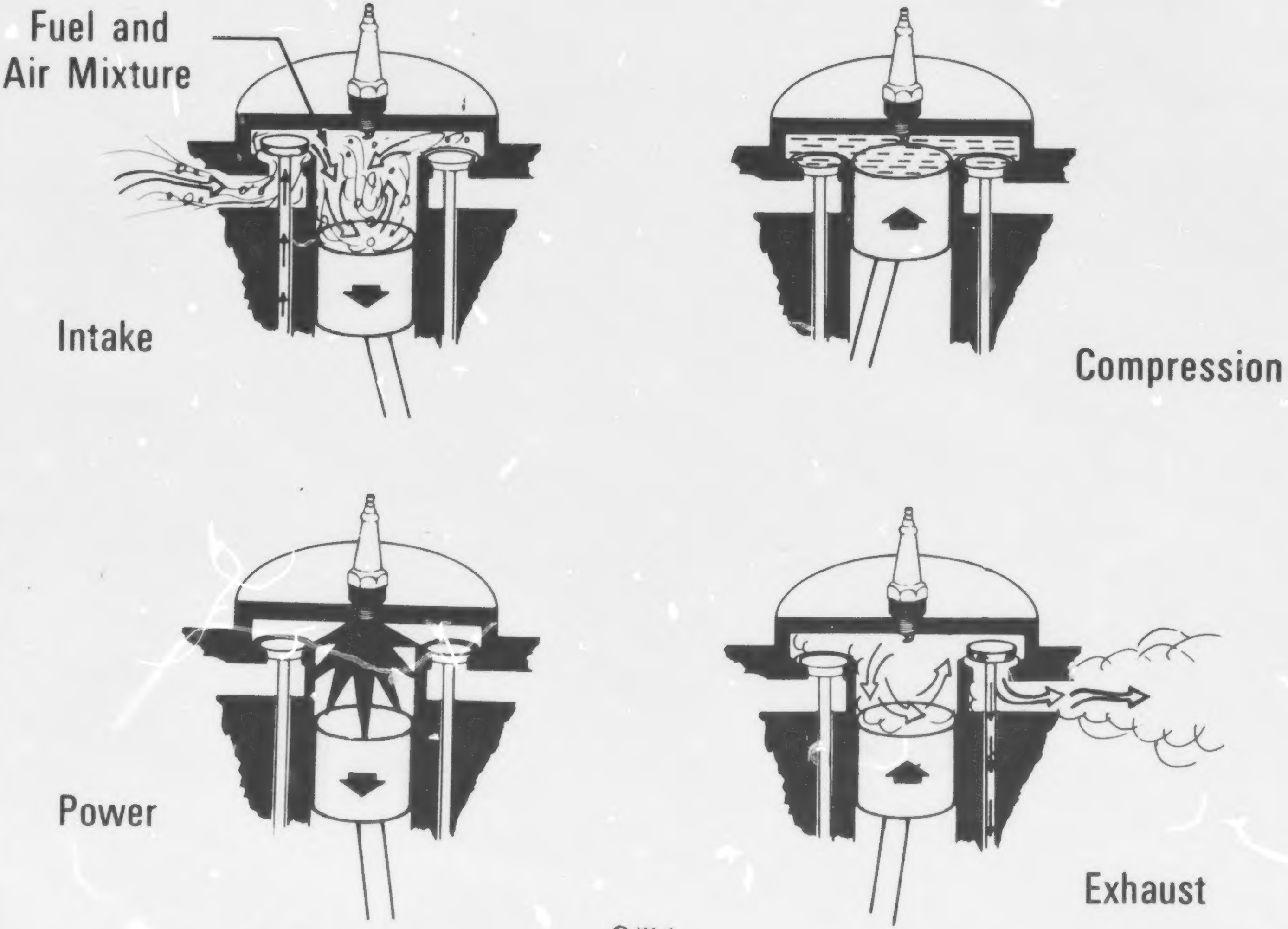
1 4 PINT JACOBSEN OIL TO 1 GALLON REGULAR GASOLINE MIX THOROUGHLY

TO START ENGINE

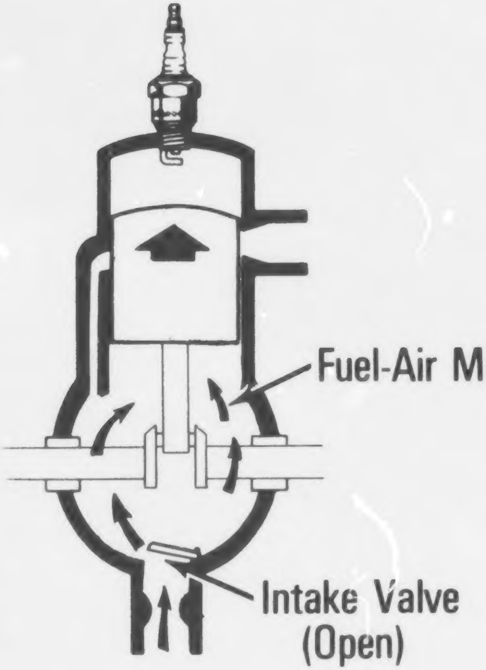
1 DISENGAGE CLUTCH ON POWER PROPELLED MODELS
2 CHECK FUEL SUPPLY & OPEN FUEL TANK SHUTOFF VALVE
3 OPEN THROTTLE AND MOVE CHOKE LEVER TO CHOKE POSITION
4 GRASP STARTER HANDLE — PULL SLOWLY AND FIRMLY
5 WHEN ENGINE STARTS MOVE CHOKE TO RUN POSITION
SEE MANUAL FOR ENGINE MAINTENANCE & ADJUSTMENTS

2-Cycle

Strokes of a Four-Stroke Cycle Engine

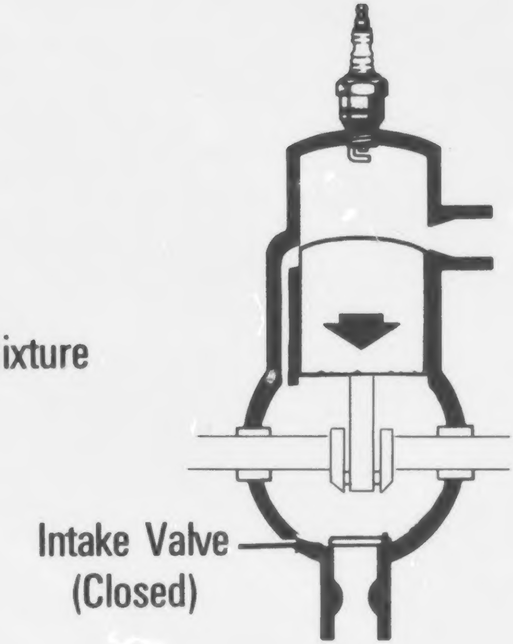

Fuel and Air Mixture
Intake
Compression
Power
Exhaust

Strokes of a Two-Stroke Cycle Engine


Fuel-Air Mixture
Intake Valve
(Open)

Intake-Compression

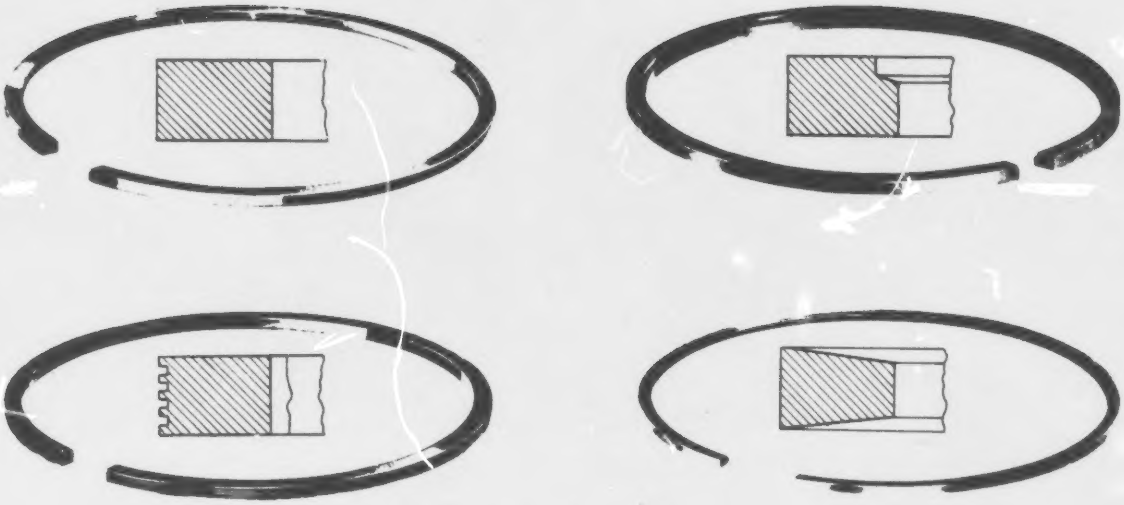
Valve opens to allow
fuel-air-and-oil mixture to
enter the crankcase


Intake Valve
(Closed)

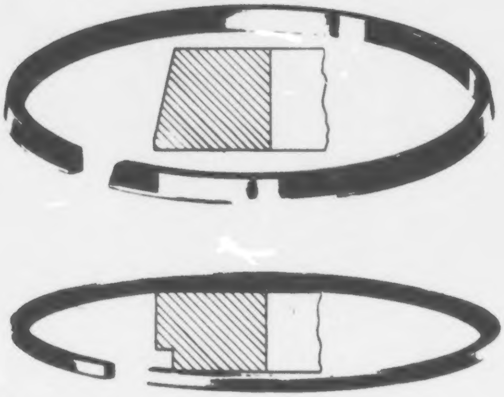
Power-Exhaust

Valve closes on the
downward stroke of the piston
to seal the crankcase

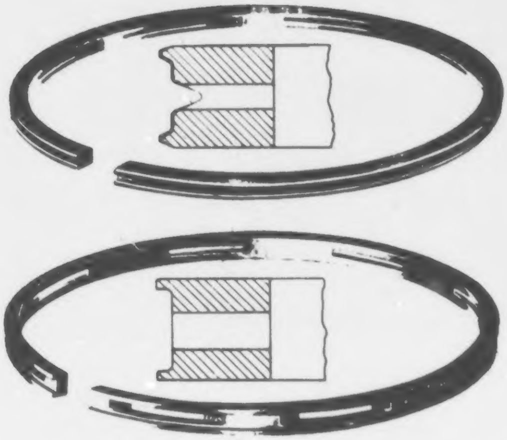
Kinds of Rings



Compression Rings

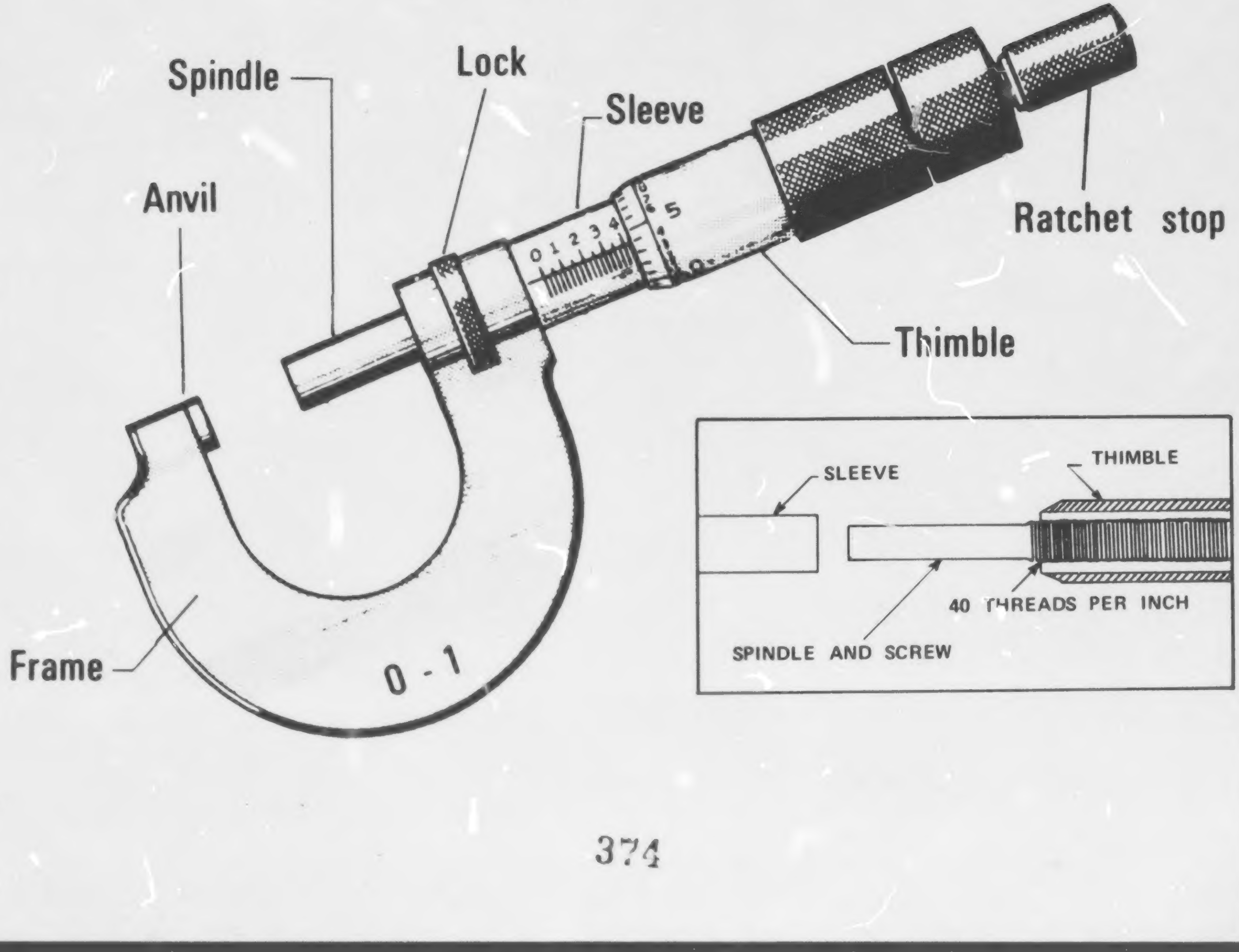


Oil Scraper Rings

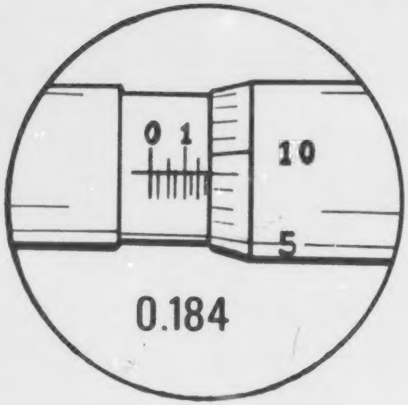


Oil Control Rings

Micrometer Parts


Spindle
Lock
Sleeve
Anvil
Ratchet stop
Thimble
Frame
0 - 1
0 1 2 3 4
5
SLEEVE
THIMBLE
40 THREADS PER INCH
SPINDLE AND SCREW

Reading a Micrometer



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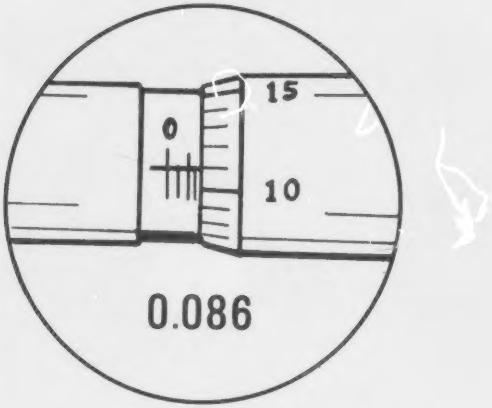

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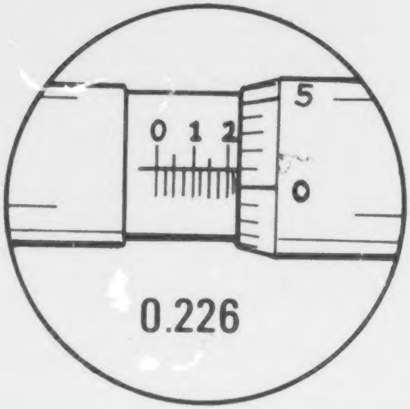
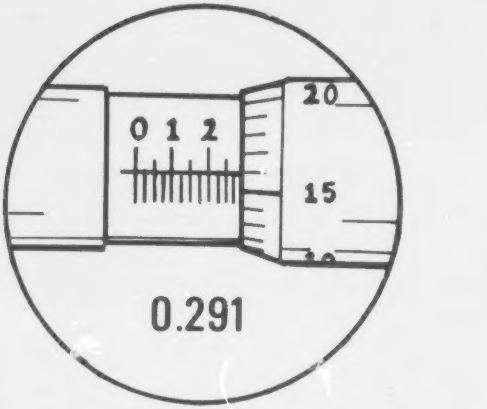


0.226

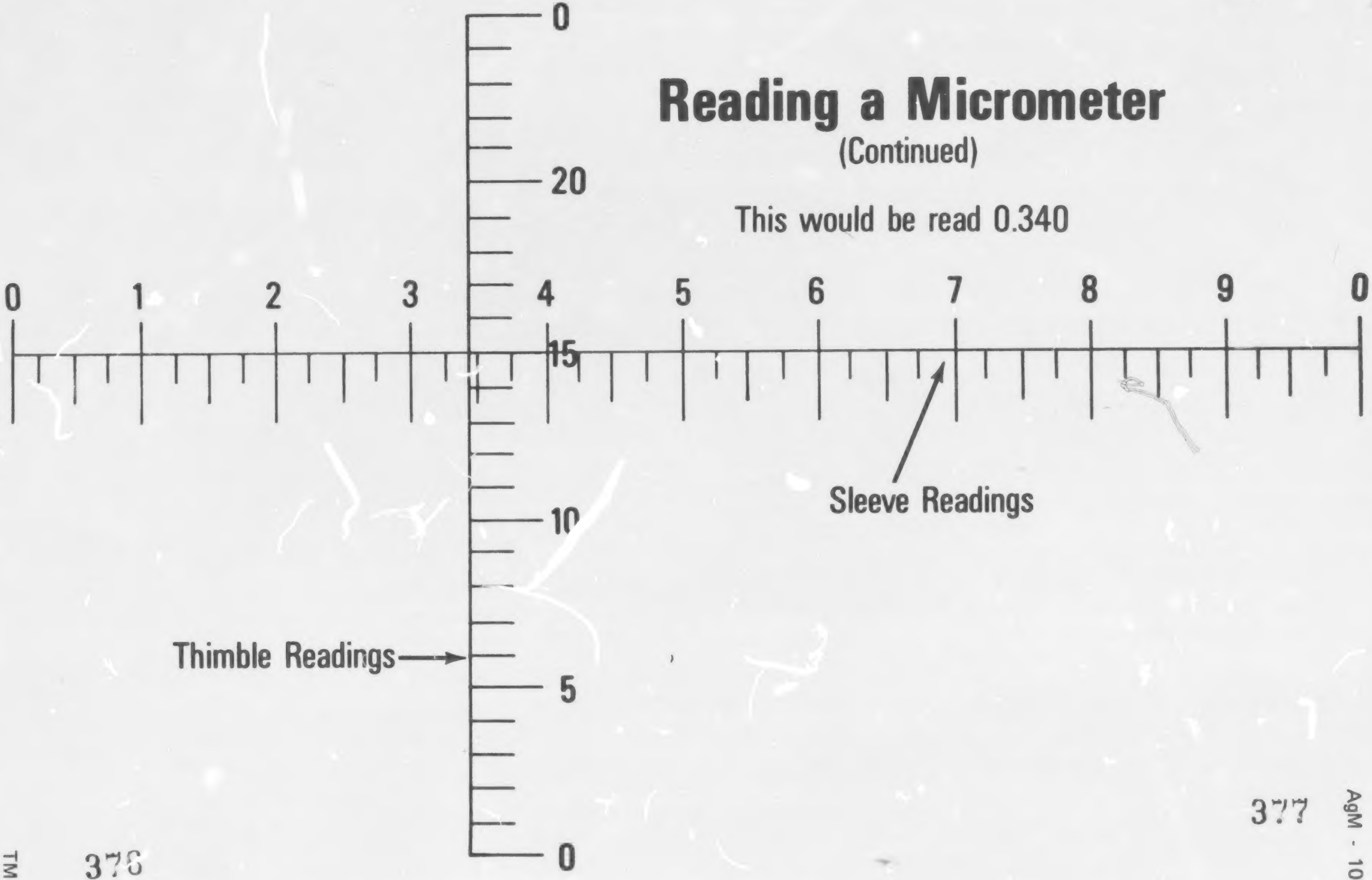


0.291

Reading a Micrometer

(Continued)

This would be read 0.340


0
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
0

Sleeve Readings

Thimble Readings

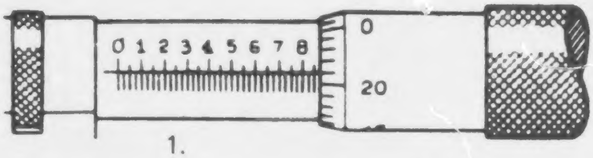
OVERHAULING SMALL GASOLINE ENGINES
UNIT II

ASSIGNMENT SHEET #1--READ THE PLAIN MICROMETER

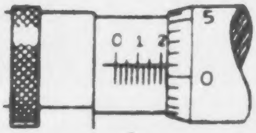
Read the plain micrometer settings below and write the correct answers in the blanks provided.

Answers

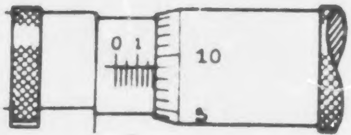
1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______


0 1 2 3 4 5 6 7 8
0
20

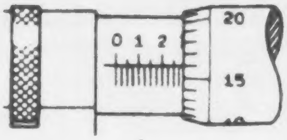
1.



2.



3.



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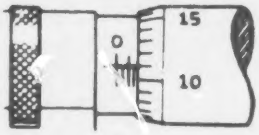
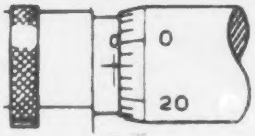
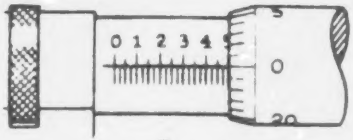


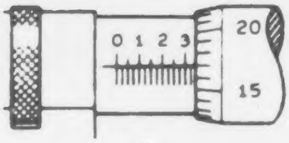
5.



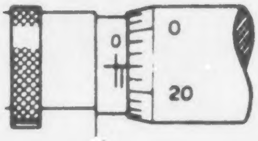
6.


0 1 2 3 4 5
5
0
20

7.



8.



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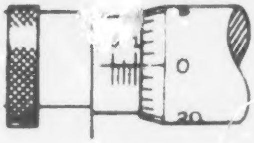


10.

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

ASSIGNMENT SHEET #2--COMPLETE ENGINE INSPECTION CHART

Complete the engine inspection chart of the engine used in either Job Sheet #1 or Job Sheet #2.

Engine: Make ______________ Model ________________
Serial No. ________________________

Specification Number ________________ Horsepower ________________

Operating Position of Crankshaft: Vertical _____, Horizontal _____, Multiposition _____.

Engine Cycle: 2-Cycle _____, 4-Cycle _____.

TYPES OF ACCESSORIES AND MAJOR UNITS:

CARBURETOR AIR CLEANER: Oil-bath ☐, Oiled-filter ☐, Dry-filter ☐.

FUEL STRAINER: Combination screen and sediment bowl ☐, Screen inside the fuel tank ☐.

CRANKCASE BREATHER: Reed valve ☐, Floating disk valve ☐.

STARTER: Rope-wind ☐, Rope-rewind ☐ Wind up ☐, Electric, AC ☐, Electric, DC ☐.

IGNITION SYSTEM: Flywheel magneto ☐, External magneto ☐, Battery ☐.

FUEL PUMP: Mechanically driven ☐, Differential pressure driven ☐.

CARBURETOR: Float ☐, Suction-lift ☐, Diaphragm ☐.

GOVERNOR: Air vane ☐, Centrifugal ☐.

TYPE OF SPARK PLUG: __________________

Gap setting: 0.020" ☐, 0.025" ☐, Other ☐ ________________

OIL RECOMMENDED: ____

IGNITION BREAKER-POINT GAP: 0.012" ☐, 0.015" ☐, Other ☐ __________.

ASSIGNMENT SHEET #2

ITEM		STANDARD	ACTUAL	RECOMMENDATION	Parts No.
CYLINDER	Diameter				
	Out of Round	0			
	Taper	0			
RING GROOVE SIDE CLEARANCE					
RING END GAP	Compression				
	Oil				
CRANKSHAFT	*Magneto Journal				
Diameter	*Crankpin				
	*P.T.O. Journal				
Out of Round	Magneto Journal	0			
	Crankpin	0			
	P.T.O. Journal	0			
MAIN BEARINGS	Magneto Journal	Use go no go gauge			
	P.T.O. Journal	Use go, no go gauge			
VALVE MARGIN		1/32"			
VALVE GUIDE		Use go, no go gauge			
BREAKER POINT PLUNGER HOLE		Use go, no go gauge			
TAPPET CLEARANCE	Intake				
	Exhaust				
BREAKER POINT GAP					
SPARK PLUG GAP					
ARMATURE AIR GAP					

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 0.871
2. 0.226
3. 0.184
4. 0.291
5. 0.086
6. 0.023
7. 0.500
8. 0.342
9. 0.047
10. 0.125

Assignment Sheet #2

Evaluated to the satisfaction of the instructor

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

JOB SHEET #1--DISASSEMBLE, INSPECT, AND REASSEMBLE A FOUR-STROKE CYCLE ENGINE

I. Tools and materials

   A. Four-stroke cycle engine

   B. Drive socket set, 3/8"

   C. Combination wrench set

   D. Standard screwdriver

   E. Phillips screwdriver

   F. Soft mallet

   G. Adjustable end wrench

   H. Pin punches

   I. Center punches

   J. Flywheel holder

   K. Flywheel puller

   L. Ring compressor

   M. Valve spring compressor

   N. Micrometer

   O. Small hole gauges

   P. Telescoping gauges

   Q. Container for holding small parts

   R. Ridge reamer

   S. Thickness gauge

   T. Torque wrench

   U. File

   V. Emery cloth

JOB SHEET #1

II. Procedure

(NOTE: Engine should be thoroughly cleaned before disassembly.)

A. Disassemble

(CAUTION: Never rotate small engines with the spark plug wire on. Always remove the plug wire before working on the engine.)

1. Drain oil from crankcase

2. Remove gasoline tank

   (NOTE: If carburetor is attached to gasoline tank, make a diagram of the throttle linkage.)

3. Remove carburetor and governor linkage

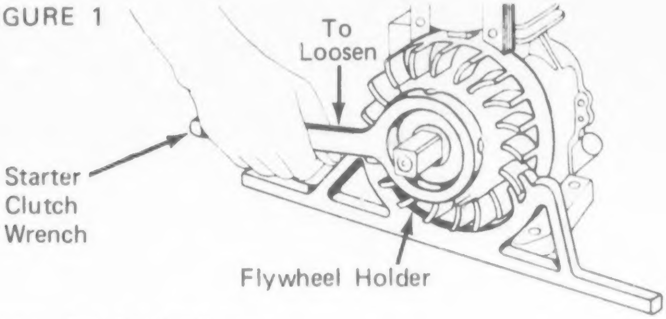
   (NOTE: Mark governor linkage and spring holes for proper position for reassembly.)

4. Remove muffler assembly

5. Remove engine shroud

6. Set engine on a flywheel holder (Figure 1)

FIGURE 1



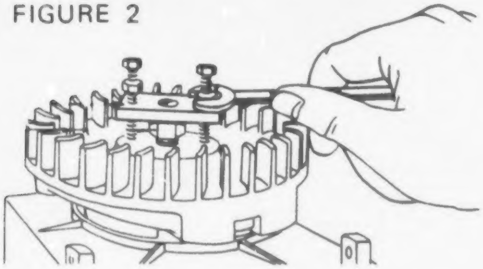
7. Remove the flywheel nut

JOB SHEET #1

8. Remove the flywheel

    a. Use pullers to remove (Figure 2)

FIGURE 2



    b. Check key and keyway

9. Remove magneto assembly, including coil, breaker points, condenser, and laminations

    (NOTE: Lay magneto aside so it will not get moisture or solvent on it.)

10. Remove cylinder head and gasket

11. Remove valve chamber cover and breather assembly

12. Compress the valve springs with a valve spring compressor (Figures 3 and 4)

FIGURE 3

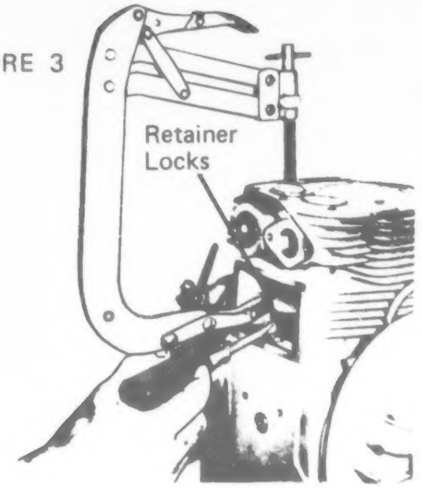
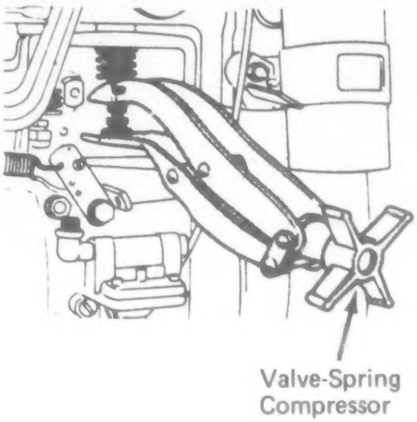


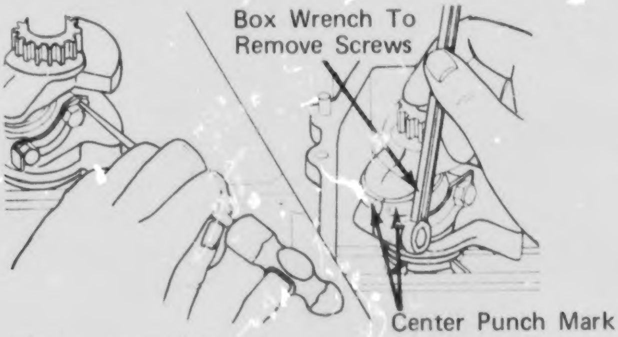
FIGURE 4



JOB SHEET #1

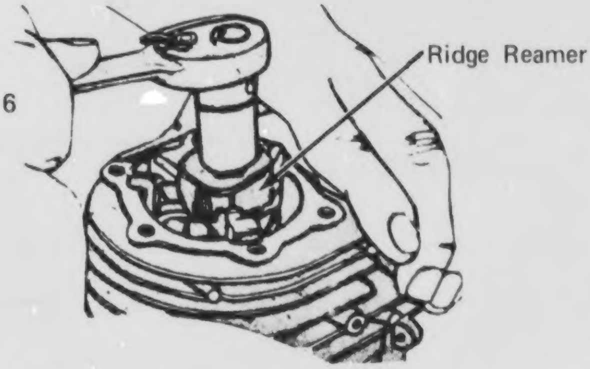
13. Remove valve spring keepers
14. Remove valves and valve springs
15. Clean dirt and grease from power take-off end of crankshaft
16. Remove any burrs on crankshaft with file or emery cloth
17. Remove base plate or end cover assembly
18. Mark connecting rod and cap with center punch (Figure 5)

FIGURE 5


Box Wrench To Remove Screws
Center Punch Mark

19. Remove cap from connecting rod
20. Remove metal ridge with ridge reamer from top of cylinder (Figure 6)

FIGURE 6


Ridge Reamer

21. Remove piston and rod assembly
22. Remove camshaft
23. Remove crankshaft
24. Remove tappets or push rods

JOB SHEET #1

B. Inspect

1. Clean all parts by washing thoroughly with solvent to remove carbon, dirt, or scale
2. Check cylinder bore for score marks
3. Check cylinder cooling fins for breaks
4. Check cylinder in the ring travel area
   a. Measure diameter at top, middle, and bottom of ring travel area
   b. Measure diameter at 90° from first measurements (Figures 7 and 8)

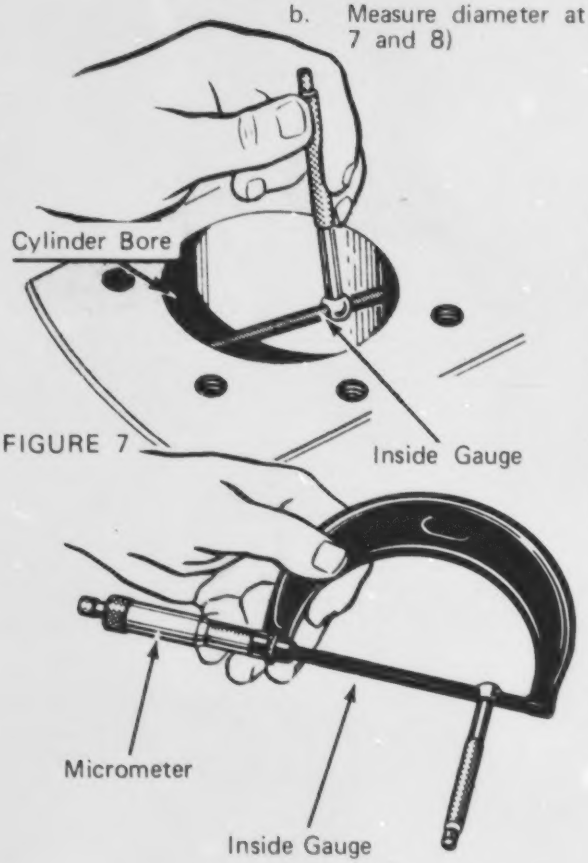
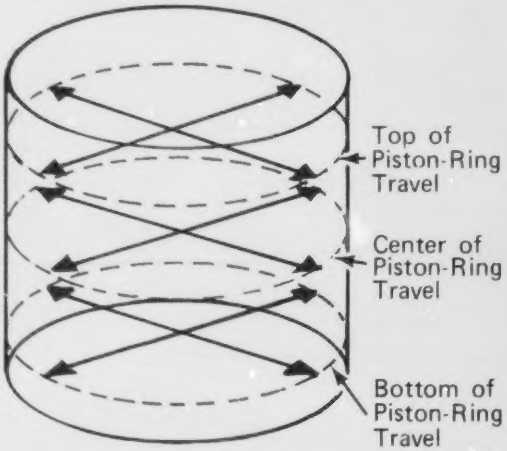

Cylinder Bore
Inside Gauge
Micrometer
Inside Gauge

FIGURE 7

FIGURE 8


Top of Piston-Ring Travel
Center of Piston-Ring Travel
Bottom of Piston-Ring Travel

   c. Determine wear and out-of-round of cylinder wall

   (NOTE: Check manufacturer's specifications for wear tolerance.)

JOB SHEET #1

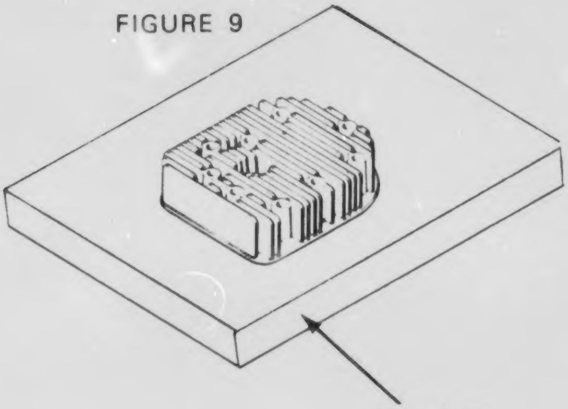
5. Check piston for wear
    a. Score of piston
    b. Ring grooves
    c. Wrist pin and bearing in connecting rod
6. Check crankshaft
    a. Flatness or out-of-round of crank journal
    b. Taper of crank
7. Check valves
    a. Heads of valves
    b. Valve seats
    c. Valve guides
8. Inspect all bearings
9. Inspect connecting rod
    a. Cracks
    b. Alignment and twist
    c. Stripped threads
    d. Wrist pin clearances and condition
    e. Connecting rod clearances
10. Inspect camshaft
    a. Lobe wear
    b. Broken gear teeth
11. Inspect lubrication system
    a. Pumps
    b. Scoops
    c. Splash system
    d. Connecting rod oil holes

JOB SHEET #1

12. Inspect cylinder head

    a. Check for warpage (Figure 9)

FIGURE 9



    b. Reface head if necessary

13. Inspect all seals

(NOTE: Measure all parts and refer to service manual for clearances. Replace parts worn beyond tolerance.)

C. Reassemble

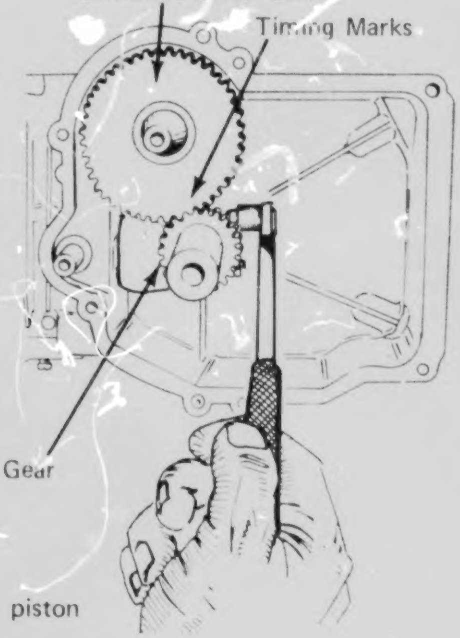
1. Replace crankshaft
2. Replace tappets and push rods

JOB SHEET #1

3. Replace camshaft

(NOTE: Make sure timing marks are aligned on camshaft gear and crankshaft gear. See Figure 10.)

FIGURE 10


Camshaft Drive Gear
Timing Marks
Crankshaft Gear

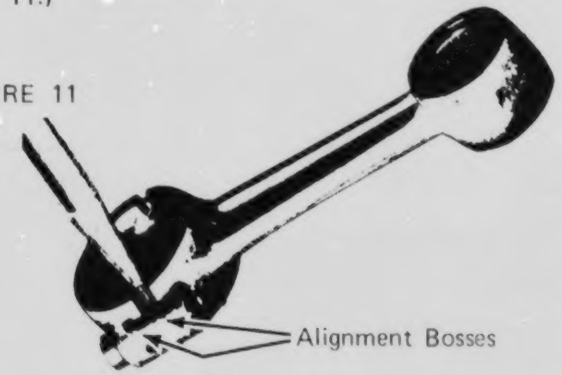
4. Install connecting rod on piston

5. Replace piston assembly into block

6. Install connecting rod cap and torque to manufacturer's specifications

(NOTE: Make sure marks on rod and cap are in alignment. See Figure 11.)

FIGURE 11


Alignment Bosses

7. Place lubrication spinner in place if used

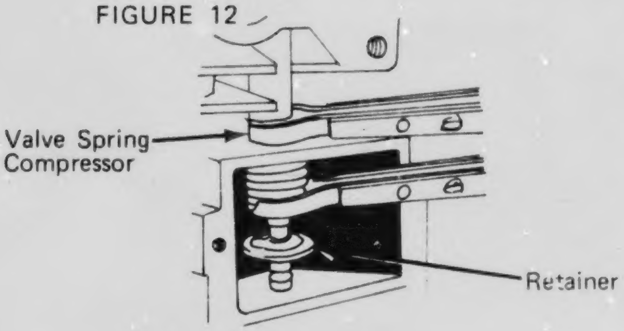
JOB SHEET #1

8. Replace base plate or end cover assembly

9. Replace valves

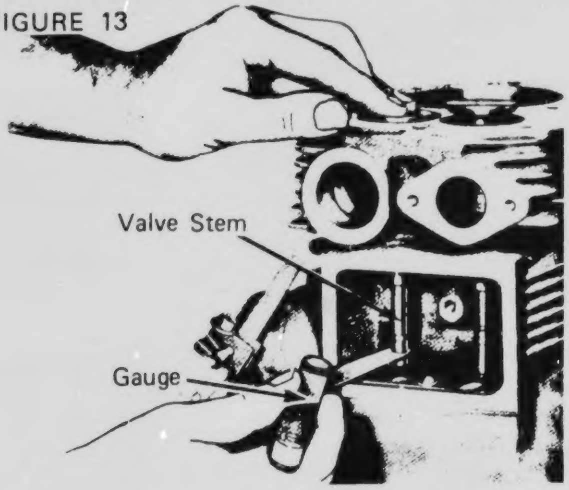
10. Install valve springs and keepers (Figure 12)

FIGURE 12



11. Check valves and tappets for proper clearances (Figure 13)

FIGURE 13



12. Install valve chamber cover and breather assembly

13. Replace cylinder head and gasket and torque to manufacturer's specifications

14. Replace magneto assembly, including coil, breaker points, condenser, and laminations

15. Replace flywheel and flywheel nut

    (NOTE: Check for proper clearances between magneto assembly and flywheel.)

JOB SHEET #1

16. Replace muffler assembly
17. Replace carburetor and governor linkage
18. Replace shrouds
19. Replace gasoline tank if separate from carburetor
20. Replace starting mechanism

    (NOTE: Check to see if engine turns freely.)
21. Fill crankcase with oil

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

JOB SHEET #2--DISASSEMBLE, INSPECT, AND REASSEMBLE A TWO-STROKE CYCLE ENGINE

I. Tools and materials

   A. Two-stroke cycle engine

   B. Drive socket set, 3/8"

   C. Combination wrench set

   D. Standard screwdriver

   E. Phillips screwdriver

   F. Soft mallet

   G. Adjustable end wrench

   H. Pin punches

   I. Center punches

   J. Flywheel holder

   K. Flywheel puller

   L. Ring compressor

   M. Valve spring compressor

   N. Micrometers

   O. Small hole gauges

   P. Telescoping gauges

   Q. Container for holding small parts

   R. Ridge reamer

   S. Thickness gauge

   T. Torque wrench

   U. Emery cloth

   V. File

√

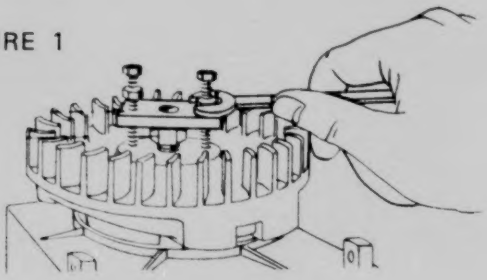
JOB SHEET #2

II. Procedure

A. Disassemble

1. Clean exterior of engine before disassembly
2. Disconnect gas line from carburetor
3. Remove plug wire
4. Remove flywheel nut and washer
5. Lift off starter pulley, plate, screen, pin, and spring from flywheel
6. Remove flywheel by using proper puller (Figure 1)

FIGURE 1

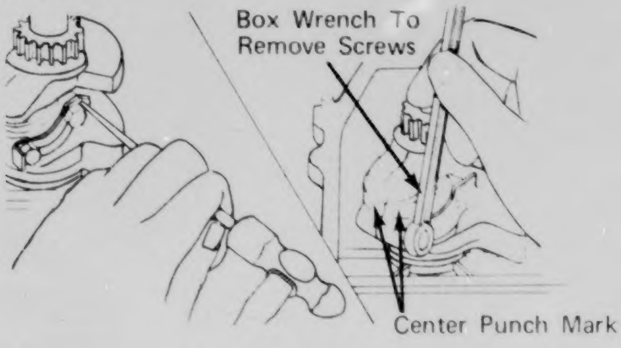


7. Lift off governor yolk arm and collar if used on the engine
8. Remove governor spring if used

   (NOTE: Make a diagram of governor linkage before removing.)

9. Remove complete magneto plate
10. Remove carburetor, air filter, and reed valve plate assembly
11. Mark connecting rod cap and rod with center punch (Figure 2)

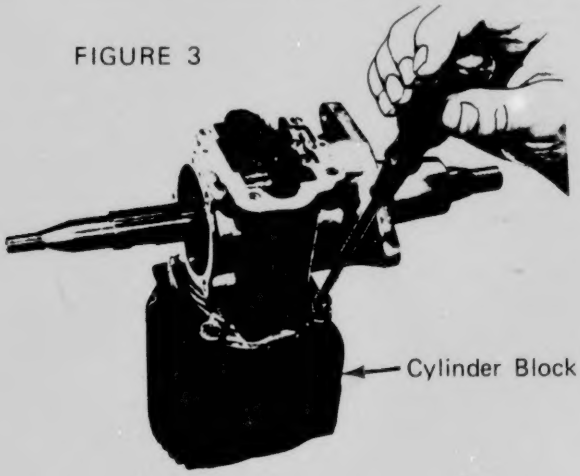
FIGURE 2



JOB SHEET #2

12. Remove connecting rod cap screws
13. Remove cylinder head, bolts, and gasket (Figure 3)

FIGURE 3



14. Remove piston, rod, and ring assembly from cylinder
15. Remove the crankshaft

B. Inspect

1. Clean all parts of the engine by washing thoroughly with solvent

   (NOTE: Do not get solvent on the magneto.)

2. Check cylinder cooling fins for breaks

JOB SHEET #2

3. Measure cylinder for taper, wear, and out-of-round (Figures 4 and 5)

FIGURE 4

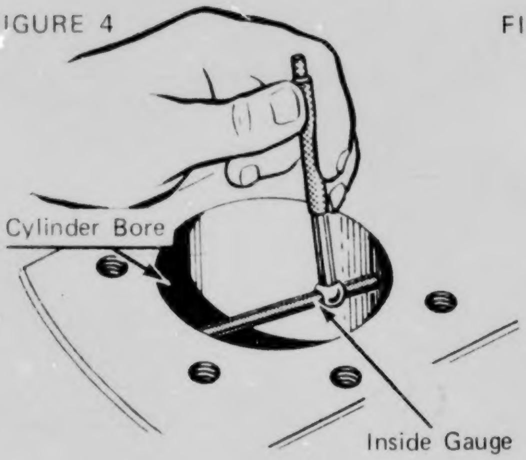
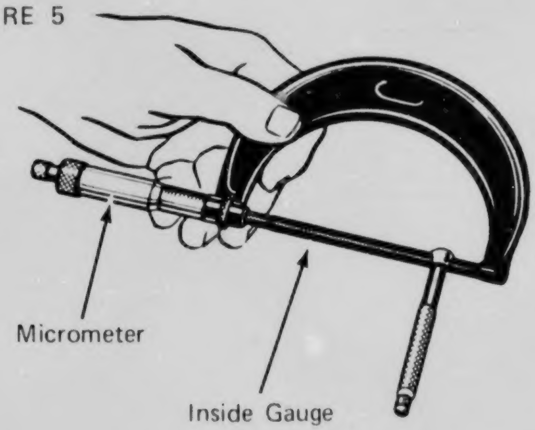

Cylinder Bore
Inside Gauge

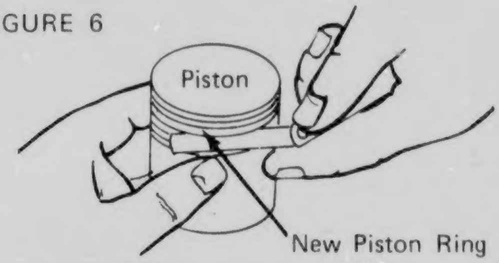
FIGURE 5


Micrometer
Inside Gauge

4. Check piston clearances using thickness gauge
5. Inspect and measure crankshaft bearing journals

   (NOTE: Check for overheating.)
6. Replace all oil seals
7. Inspect and check piston rings (Figure 6)

FIGURE 6


Piston
New Piston Ring

8. Inspect and check connecting rod
   a. Check bearings
   b. Check for cracks
   c. Check rod clearances
9. Check cylinder for score marks

JOB SHEET #2

10. Inspect magneto

    a. Check for loose mounting screws

    b. Check contact point air gap

    c. Check condition of points

    d. Check rubbing block (fiber block) for wear and lubrication

    e. Check for wear between crankshaft and magneto plate bearing

    f. Test coil and condenser

    g. Adjust ignition points to properly specified gap

    h. Check primary and secondary wire for insulation breaks

    (NOTE: During inspection of the engine parts, service manual tolerance should be observed when taking measurements. Replace all worn parts.)

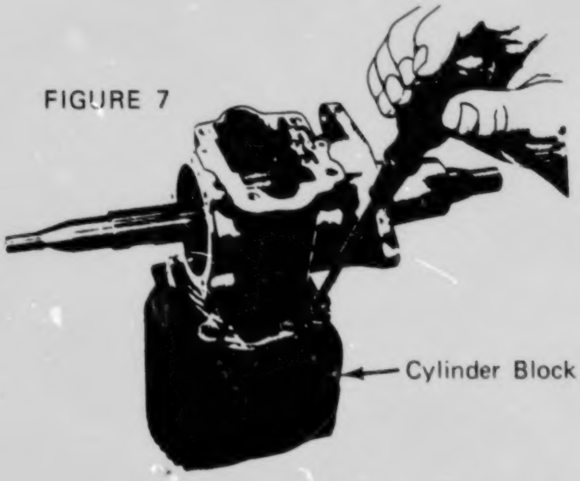
C. Reassemble

1. Replace crankshaft

2. Install piston, rod, and ring assembly in cylinder

3. Replace cylinder head, bolts, and gasket (Figure 7)

FIGURE 7

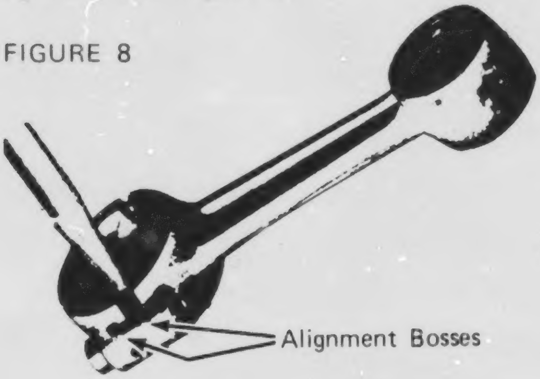


JOB SHEET #2

4. Connect rod to crankshaft

   (NOTE: Make sure marks on the cap and rod are in proper alignment. See Figure 8.)

   FIGURE 8

5. Replace carburetor, air filter, and reed plate assembly
6. Replace magneto plate
7. Replace governor spring if used
8. Replace governor yolk arm and collar if used
9. Install flywheel on crankshaft
10. Replace starter pulleys, plate, screen, pin, and spring on flywheel
11. Install flywheel nut and washer
12. Replace plug wire
13. Connect gas line to carburetor

(NOTE: In overhauling two-stroke cycle engines, follow manufacturer's recommendations on all clearances and tolerances.)

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

JOB SHEET #3--REFACE VALVES AND VALVE SEATS

I. Tools and materials

  A. Exhaust and intake valves

  B. Valve grinding machine

  C. Safety goggles

  D. Small engine block

  E. Valve seat grinding machine

II. Procedure

  A. Reface valves

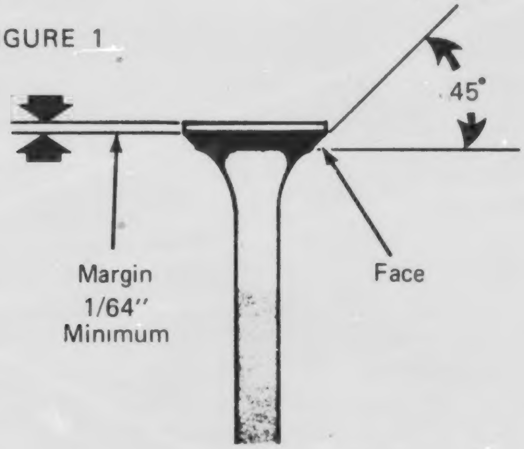
    1. Check valve for worn areas, cracks in head, or damaged areas

    2. Dress the valve grinding wheel if needed

    3. Adjust the valve grinder for grinding the proper face angle

    (NOTE: Check manufacturer's recommendations for proper angle. See Figure 1.)

FIGURE 1



JOB SHEET #3

4. Place valve in grinder chuck and tighten it securely (Figures 2 and 3)

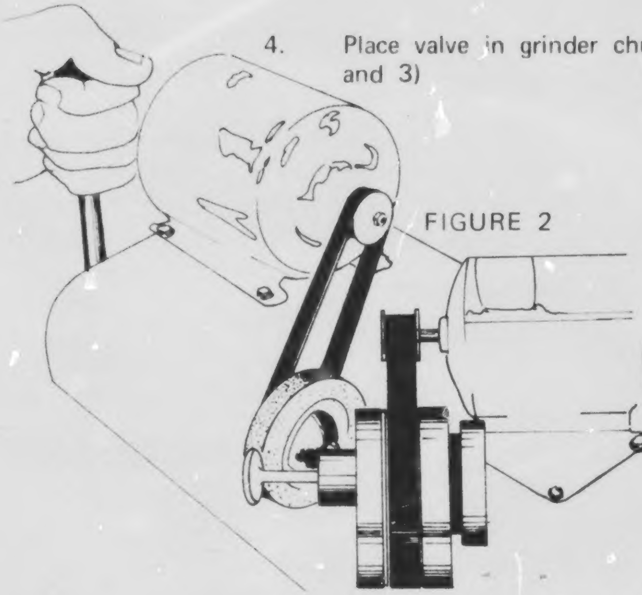


FIGURE 2

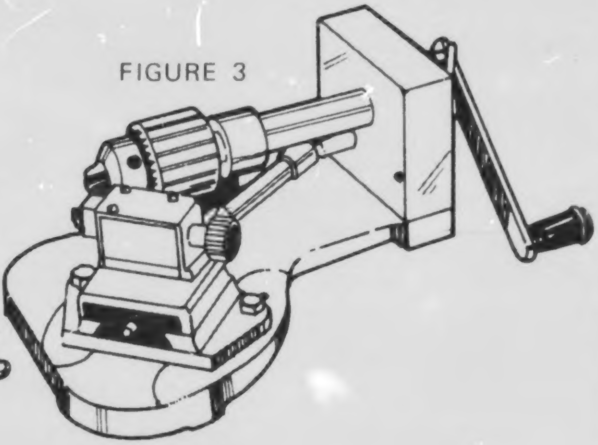


FIGURE 3

5. Check to see that the valve face is in proper position to contact the grinding wheel

   (NOTE: Make sure the valve head is straight and does not wobble due to a bent valve stem.)

6. Move valve in and out before starting grinder

7. Set the machine so the wheel will not contact the valve stem

8. Start grinder

9. Make sure cutting oil is flowing

10. Move the valve face up to the wheel and start grinding tightly

11. Take light cuts and continue until the grinding sound is regular

    (NOTE: Do not try to finish the grinding without checking the progress often.)

12. Remove the valve from the grinding machine

13. Check the valve face width

    (NOTE: You may not be able to grind the valve face adequately before grinding the margin too thin. If the margin is less than 1/64" or less than half the thickness of the new valve margin, discard the valve.)

14. Stop the grinder

JOB SHEET #3

15. Clean valve with petroleum solvent

B. Reface valve seats (electric power grinder)

1. Select a grinding wheel with the proper angle

   (NOTE: Check manufacturer's recommendations for proper angle.)

2. Be sure wheel is dressed properly

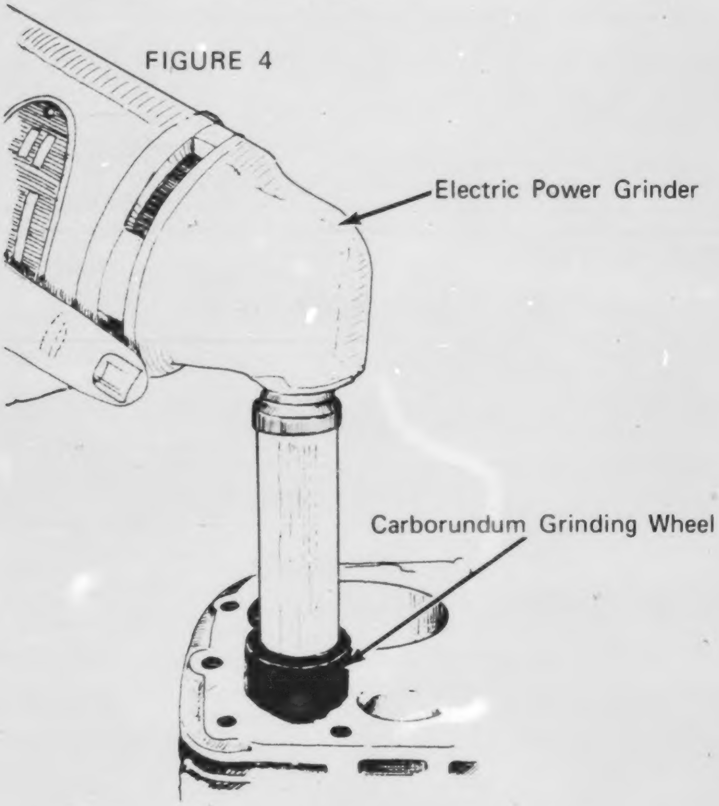
3. Install the pilot in the valve guide

   (NOTE: It is very important that the valve guides be checked and replaced, if necessary, before grinding the valve seats.)

4. Slip the grinding wheel over the pilot

5. Grind the valve seat (Figure 4)

FIGURE 4

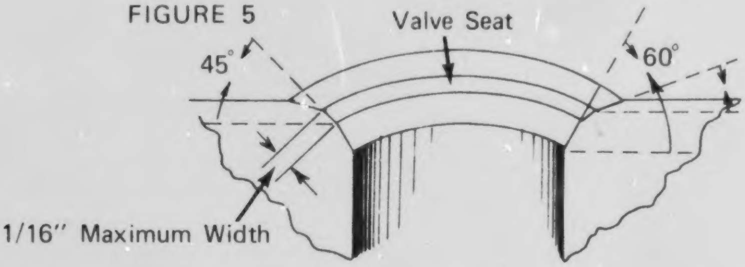


JOB SHEET #3

6. Check the width of valve seat (Figure 5)

   (NOTE: Width of face of valve seat should not be more than 1/16" wide or the valve will not seat properly.)

FIGURE 5



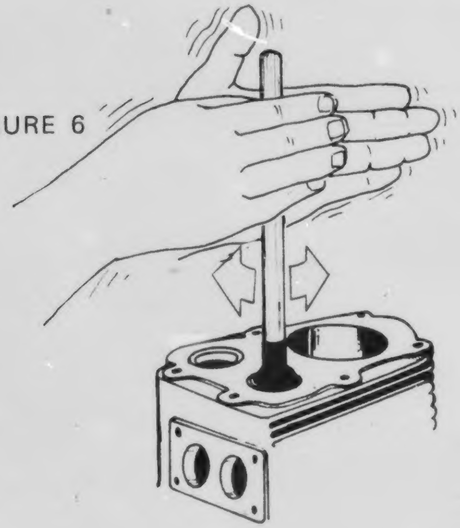
7. Smooth burred edge with the original seat-grinding wheel

8. Check the valve in the seat

   (NOTE: Use of prussion blue will indicate if valve face and seat are matched. Sometimes a shift imperfection can be corrected by "lapping" the valve and seat with a lapping compound.)

9. Lap the valve to the seat if necessary (Figure 6)

FIGURE 6



OVERHAULING SMALL GASOLINE ENGINES
UNIT II
JOB SHEET #4--REPLACE RINGS

I. Tools and materials

  A. Piston

  B. Ring expander

  C. Special scraper tool

  D. Micrometer

  E. Piston-ring groove gauge

  F. Thickness gauge

  G. Set of rings

  H. Solvent

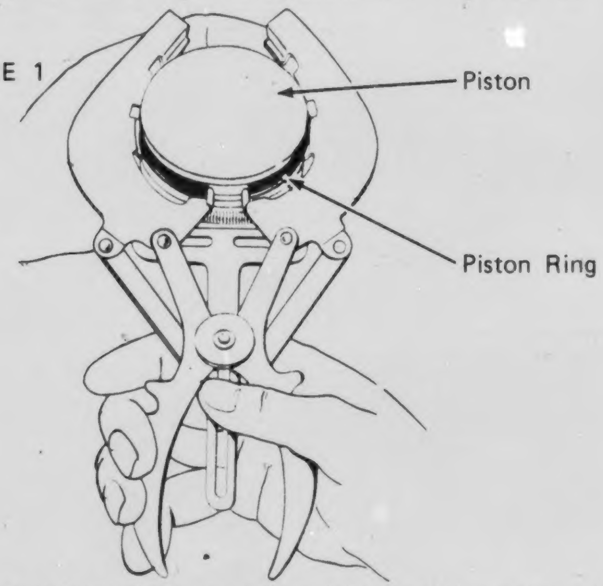
  I. Shop towels

II. Procedure

  A. Clean and inspect piston and rings

    1. Remove old rings from piston with ring expander (Figure 1)

FIGURE 1



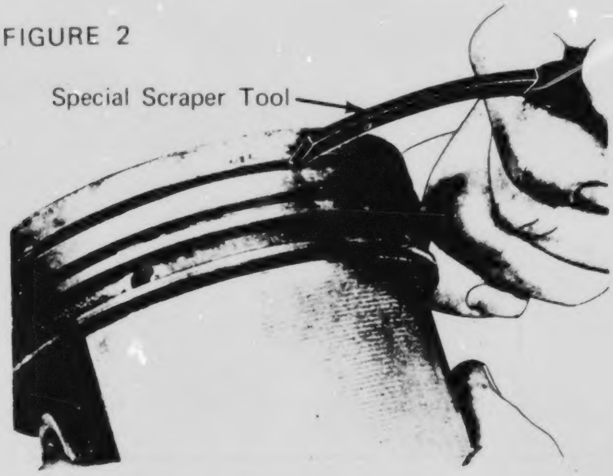
    2. Soak the piston and rings in a special carbon solvent

JOB SHEET #4

3. Scrape the carbon from the ring groove with the special scraping tool (Figure 2)

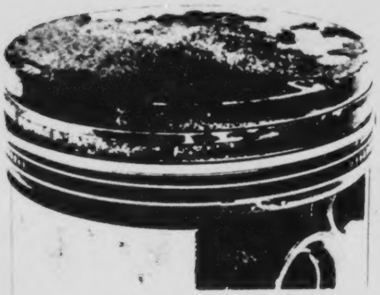
   (NOTE: Be careful not to scratch the piston.)

FIGURE 2



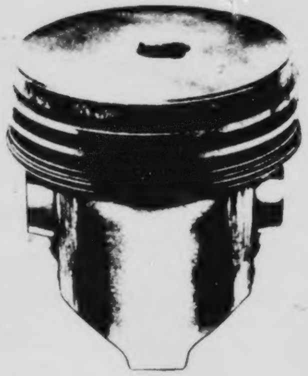
4. Check the condition of the piston and rings (Figures 3, 4, and 5)

FIGURE 3



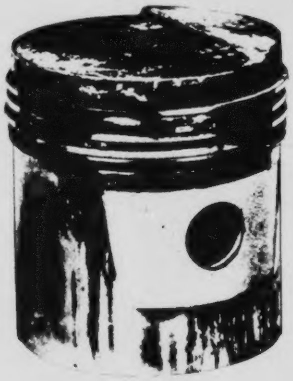
Detonation

FIGURE 4



Preignition

FIGURE 5



Scuffing

   a. Check for burning, top groove wear, and broken or stuck rings
   b. Check for scuffing and scoring
   c. Check for scratches on the piston and the ring

JOB SHEET #4

5. Measure the piston for wear (Figures 6 and 7)

   (NOTE: Check manufacturer's recommendations for critical clearances on wear.)

FIGURE 6

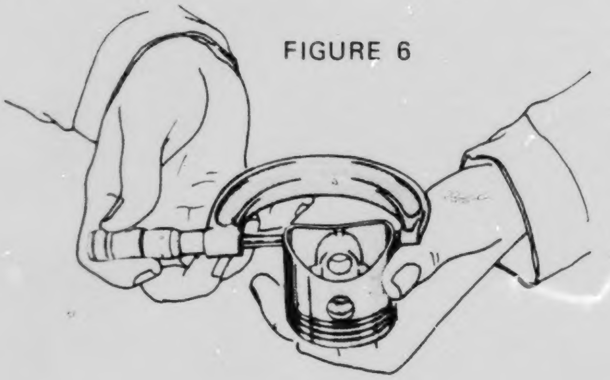
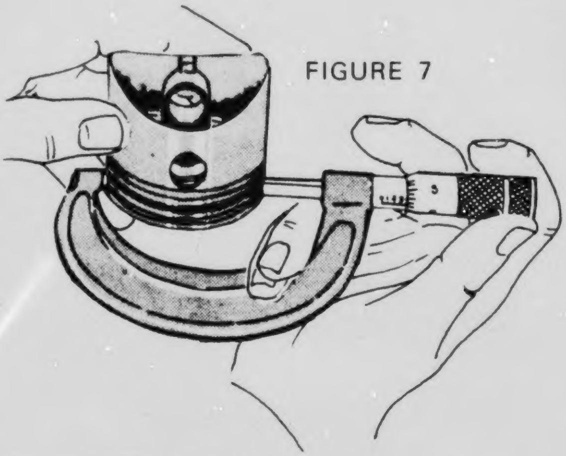


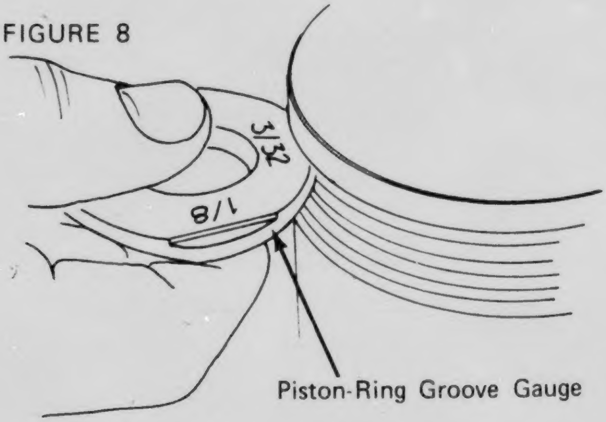
FIGURE 7



6. Check the ring groove wear with ring-groove gauge (Figure 8)

   (NOTE: Check manufacturer's specifications on ring groove wear.)

FIGURE 8



Piston-Ring Groove Gauge

7. Check rings for wear (Figures 9 and 10)

   a. Insert the rings one at a time into cylinder

   b. Push rings in with a piston with rings removed

JOB SHEET #4

c. Measure the ring gap with thickness gauge

(NOTE: Check manufacturer's specifications for tolerance.)

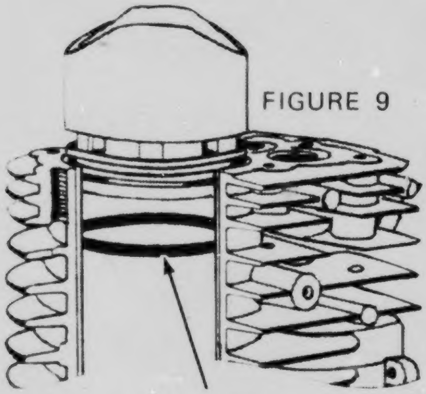


FIGURE 9

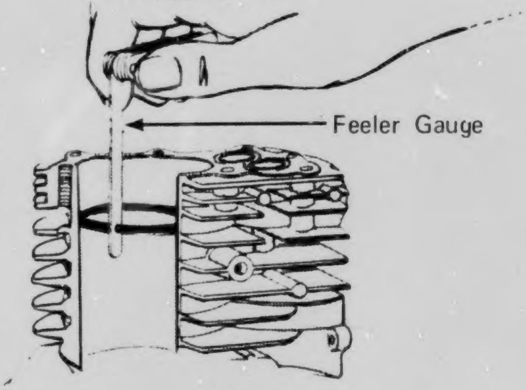


FIGURE 10

B. Check end gap if new rings are to be installed (Figures 9 and 10)

1. If the end gap is too small, file the end to proper gap
2. If the end gap is too large, then the ring size is wrong or the cylinder is worn too much and must be rebored and an oversized piston and rings installed

C. Apply crankcase oil to the rings and piston

D. Install the rings on the piston using the ring expander (Figure 11)

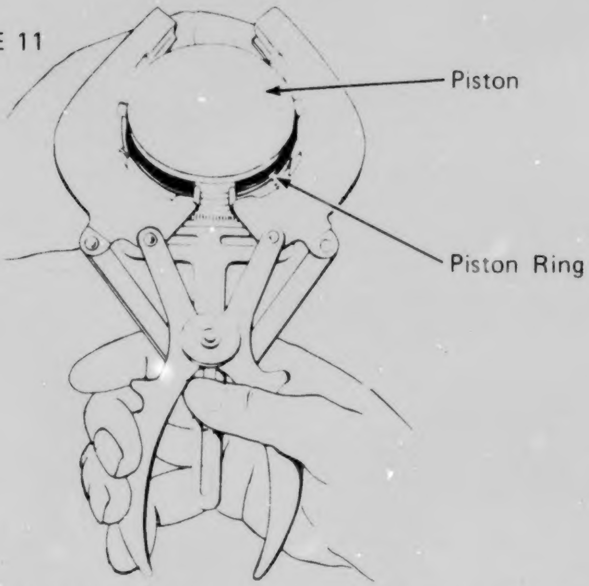
(CAUTION: Be careful not to break ring.)

1. Begin with bottom ring
2. Install ring expanders first if they are used

   (CAUTION: Be sure to install the ring right side up. Some rings are marked top; others are not marked. Check service or operation manual.)

JOB SHEET #4

FIGURE 11


Piston
Piston Ring

E. Check the rings for freedom of movement in the grooves

F. Stagger the ring gap (Figures 12 and 13)

(NOTE: Ring gaps should be staggered to insure proper compression in the cylinder.)

FIGURE 12

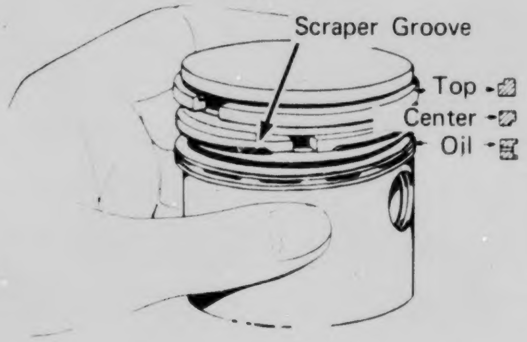
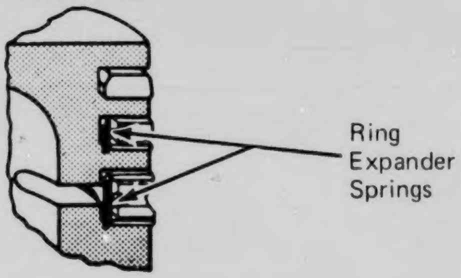

Scraper Groove
Top
Center
Oil

FIGURE 13


Ring
Expander
Springs

G. Replace piston and rod assembly in cylinder using the ring compressor

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

TEST

NAME ________________________________ SCORE ____________________

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. Device inserted into the combustion chamber of an engine to produce the spark to ignite the compressed fuel-air mixture

_____b. Largest single piece of an engine; basis or main mass of metal in which the cylinders are bored or placed

_____c. Cylindrical part closed at one end which is connected to the crankshaft by the connecting rod

_____d. Material along or through which electricity will flow with slight resistance

_____e. Area of the cylinder above the piston with the piston at top dead center

_____f. Scratch, ridge, or groove marring a finished surface

_____g. Device for temporarily collecting and storing an overflow of electrical current for later discharge

_____h. Valve which permits fuel-air mixture to enter the combustion chamber or cylinder and then seals the exit

_____i. Expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fuel-air mixture past the piston

_____j. Hole in engine block which receives a piston; sometimes referred to as *bore* or *barrel*

_____k. Reduction in volume of fuel-air mixture within the cylinder

1. Intake valve
2. Piston
3. Spark plug
4. Combustion chamber
5. Compression
6. Condenser
7. Conductor
8. Cylinder block
9. Piston ring
10. Score
11. Cylinder

______l. Device which permits the spent fuel-air mixture to leave the combustion chamber

______m. Burning process

______n. Pipe connecting the engine to the muffler to conduct the exhaust gases away from the engine

______o. Rod that connects the piston to the crankshaft

______p. Detachable portion of an engine fastened securely to the cylinder block which contains all or a portion of the combustion chamber

______q. Shaft containing lobes or cams to operate the engine's valves

______r. Pin that goes through the small end of the connecting rod which also passes through the piston walls; also known as *wrist pin*

______s. Means for igniting the fuel in the combustion chamber; includes spark plugs, wires, ignition coil, points, condenser, and source of electrical current

______t. Device for automatically mixing fuel in the proper proportions with air to produce a combustible gas

______u. Main shaft of the engine which, in conjunction with the connecting rods, changes the reciprocating motion of the pistons into rotary motion

______v. Space between the electrodes of a spark plug through which the spark jumps

______w. Control device used to regulate engine speed

______x. Part of the piston above the rings

______y. Housing in which the crankshaft and many other parts of the engine operate

12. Spark
13. Spark gap
14. Combustion
15. Stroke
16. Exhaust valve
17. Connecting rod
18. Cylinder head
19. Exhaust pipe
20. Gasket
21. Governor
22. Ignition system
23. Camshaft
24. Carburetor
25. Piston head
26. Piston pin
27. Crankcase
28. Crankshaft

(NOTE: Definitions are continued on the next page.)

______z. Distance piston travels inside the cylinder

____aa. Anything used as a packing, such as nonmetallic substance, placed between two metal surfaces to act as a seal

____bb. Electrical current possessing sufficient pressure to jump through the air from one conductor to another

2. List four systems found in a small gasoline engine.

a. ____

b. ____

c. ____

d. ____

3. Identify parts of the small horizontal shaft gasoline engine on the next page by writing the correct names in the blanks provided.

a. ________________

b. ________________

c. ________________

d. ________________

e. ________________

f. ________________

g. ________________

h. ________________

i. ________________

j. ________________

k. ________________

l. ________________

m. ________________

n. ________________

o. ________________

p. ________________

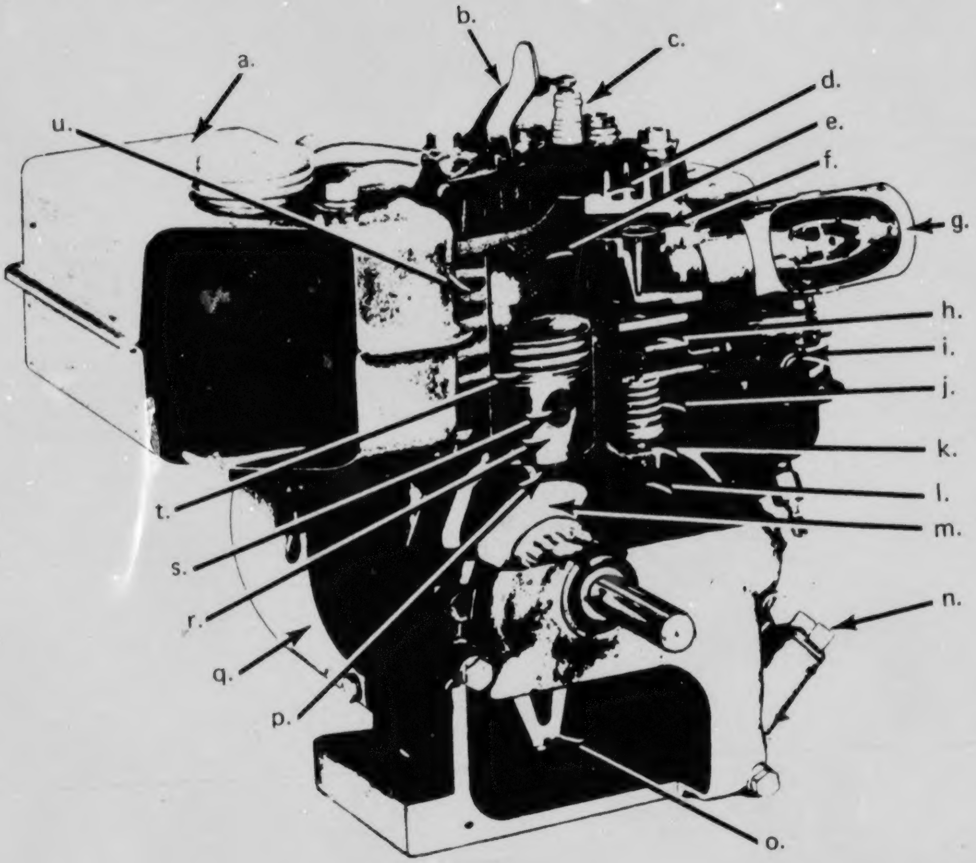
q. ________________

r. ________________

s. ____________

t. ____________

u ____________


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.
m.
n.
o.
p.
q.
r.
s.
t.
u.

4. Identify the following special tools needed in overhauling small engines. Write the correct names in the blanks provided.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

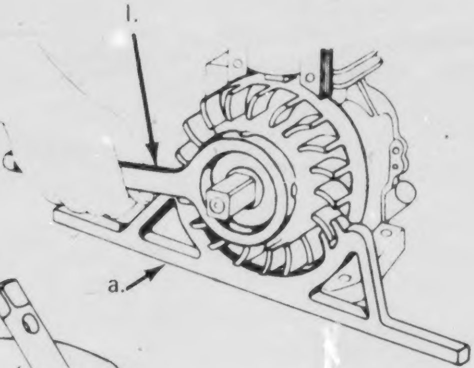
h. ____________________

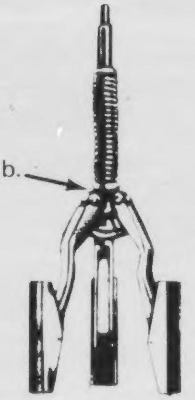
i. ____________________

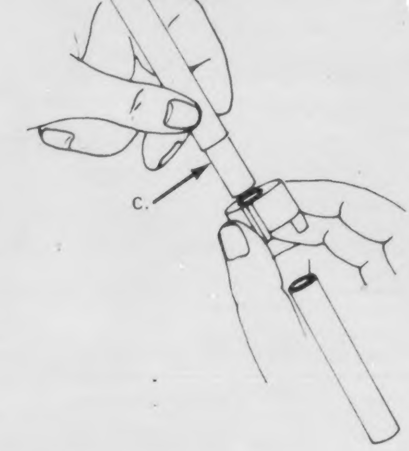
j. ____________________

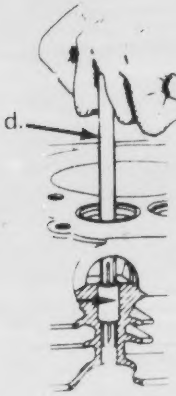
k. ____________________

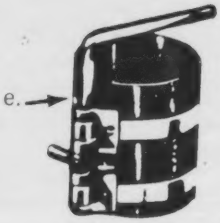
l. ____________________

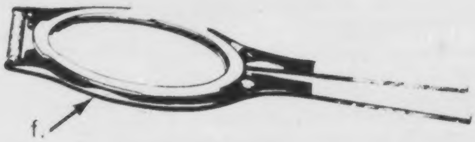


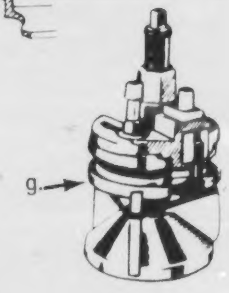


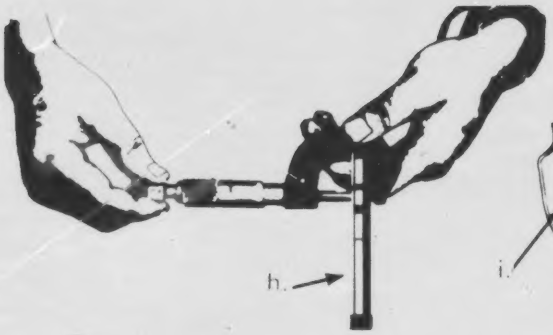


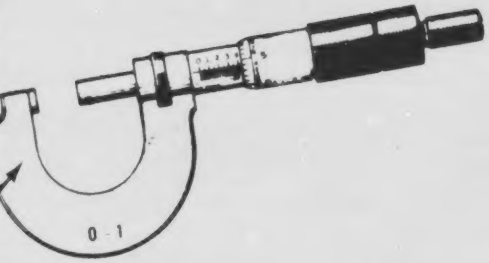


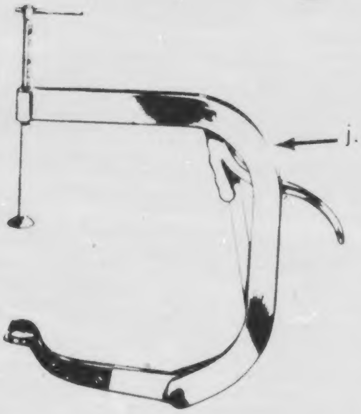


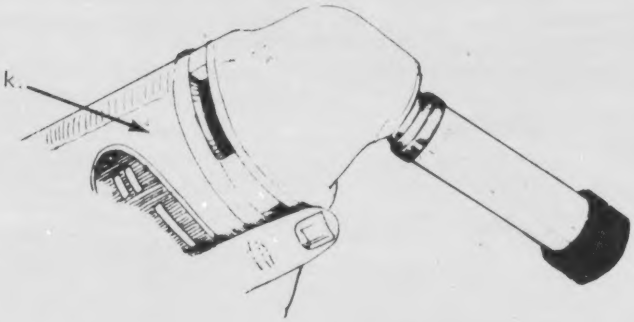





h.


i.
0 - 1


j.


k.

5. List five uses for small gasoline engines.

a. ______________________________

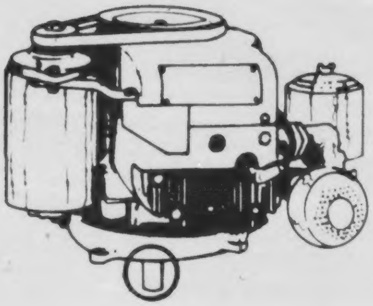
b. ______________________________

c. ______________________________

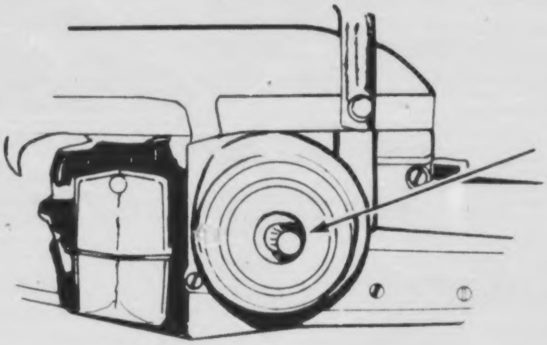
d. ______________________________

e. ______________________________

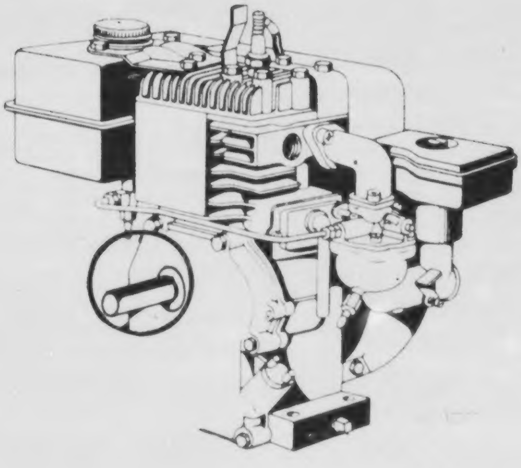
6. Identify the basic operating positions of small gasoline engines by writing the positions in the blanks provided.



a. ____________



b. ____________



c. ____________

7. List five items found on an engine nameplate.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

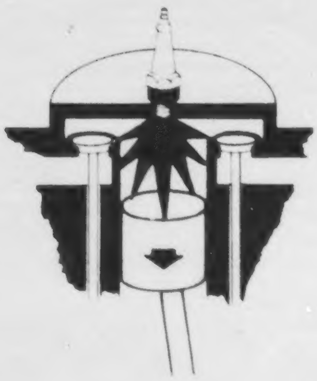
   e. ______________________________

8. State the importance of being able to read an engine nameplate.

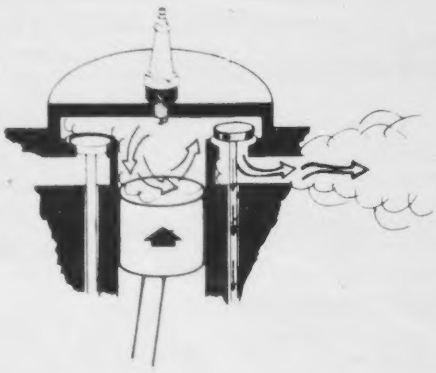
9. Describe the differences between two-stroke and four-stroke cycle engines.

10. Identify the strokes of a four-stroke cycle engine and a two-stroke cycle engine by writing the correct names in the blanks provided.

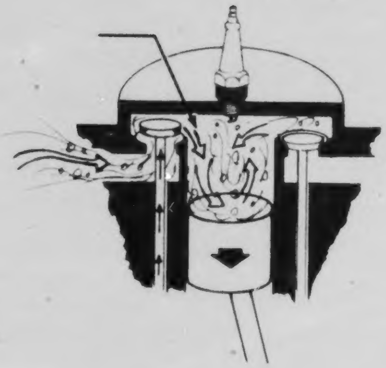
    a. Four-stroke cycle engine

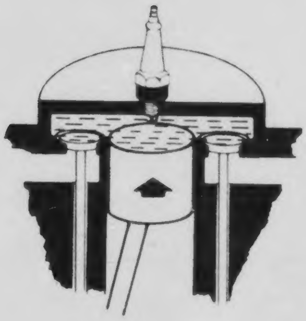


1) ____________________



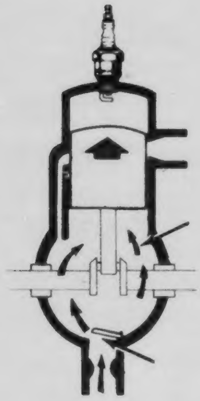
2) ____________________

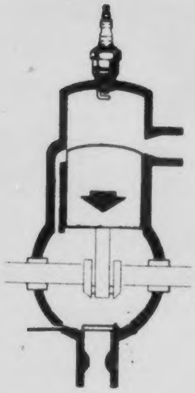




3) ________________ 4) ________________

b. Two-stroke cycle engine





1) ________________ 2) ________________

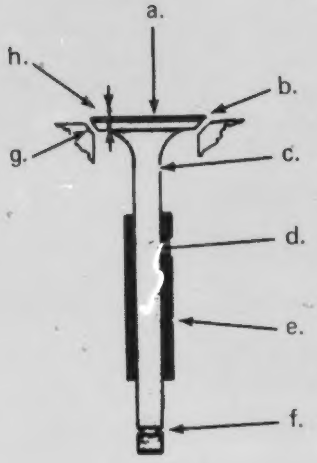
11. Identify the parts of a valve on the next page by writing the correct names in the blanks provided.

a. ________________ e. ________________

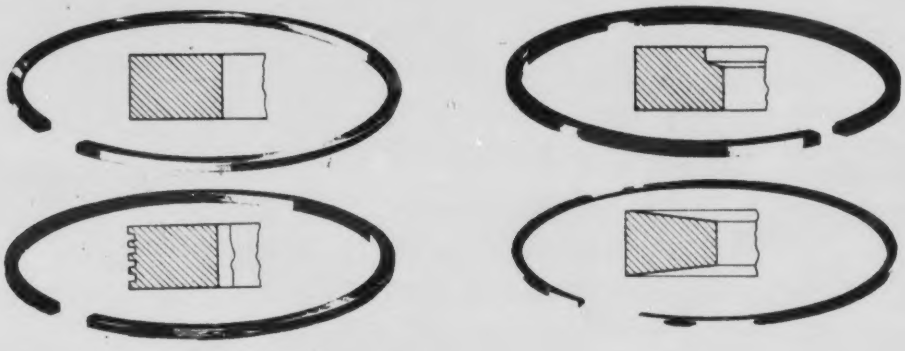
b. ________________ f. ________________

c. ________________ g. ________________

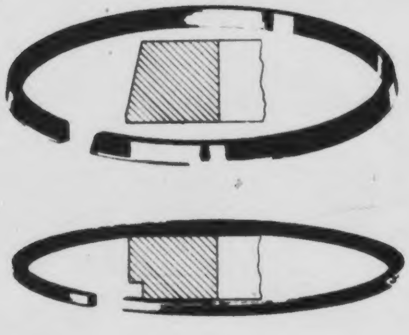
d. ________________ h. ________________



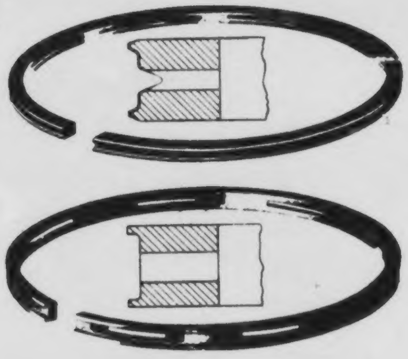
12. Identify the following kinds of rings by writing the correct names in the blanks provided.



a. ______________________



b. ______________________



c. ______________________

13. Match the kinds of rings to their specific purposes by writing the correct numbers in the blanks provided.

_____a. Regulate the amount of oil going to the compression rings and cylinder wall

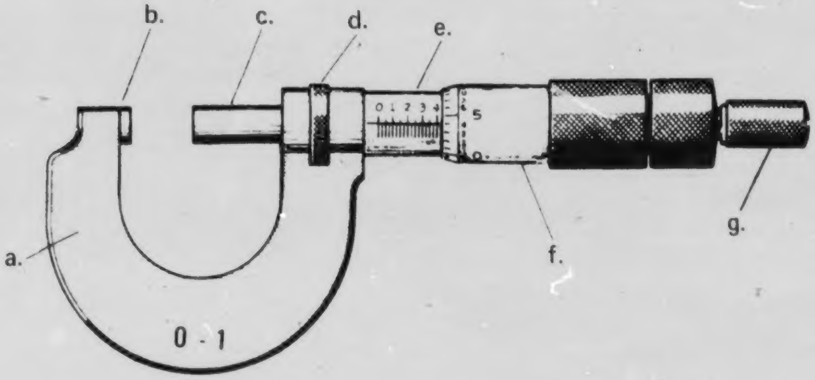
_____b. Make a tight seal against cylinder wall

_____c. Wipe excess oil off cylinder wall as piston moves down

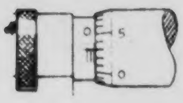
1. Compression rings
2. Oil scraper rings
3. Oil control rings

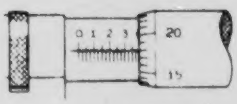
14. Identify the parts of the plain micrometer by writing the correct names in the blanks provided.

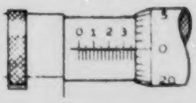
a. ______________________
b. ______________________
c. ______________________
d. ______________________
e. ______________________
f. ______________________
g. ______________________



15. Read the plain micrometer by writing the readings in the blanks provided.







a. ________________ b. ________________ c. ________________

16. Complete engine inspection chart.

17. Demonstrate the ability to:

    a. Disassemble, inspect, and reassemble a four-stroke cycle engine.

    b. Disassemble, inspect, and reassemble a two-stroke cycle engine.

    c. Reface valves and valve seats.

    d. Replace rings.

    (NOTE: If activities 16-17 have not been accomplished prior to the test, ask your instructor when they should be completed.)

OVERHAULING SMALL GASOLINE ENGINES
UNIT II

ANSWERS TO TEST

1. Match terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

3 a. Device inserted into the combustion chamber of an engine to produce the spark to ignite the compressed fuel-air mixture

8 b. Largest single piece of an engine; basis or main mass of metal in which the cylinders are bored or placed

2 c. Cylindrical part closed at one end which is connected to the crankshaft by the connecting rod

7 d. Material along or through which electricity will flow with slight resistance

4 e. Area of the cylinder above the piston with the piston at top dead center

10 f. Scratch, ridge, or groove marring a finished surface

6 g. Device for temporarily collecting and storing an overflow of electrical current for later discharge

1 h. Valve which permits fuel-air mixture to enter the combustion chamber or cylinder and then seals the exit

9 i. Expanding ring placed in the grooves of the piston to provide a seal to prevent the passage of fuel-air mixture past the piston

11 j. Hole in engine block which receives a piston; sometimes referred to as *bore* or *barrel*

5 k. Reduction in volume of the fuel-air mixture within the cylinder

1. Intake valve
2. Piston
3. Spark plug
4. Combustion chamber
5. Compression
6. Condenser
7. Conductor
8. Cylinder block
9. Piston ring
10. Score
11. Cylinder

16 l. Device which permits the spent fuel-air mixture to leave the combustion chamber

14 m. Burning process

19 n. Pipe connecting the engine to the muffler to conduct the exhaust gases away from the engine

17 o. Rod that connects the piston to the crankshaft

18 p. Detachable portion of an engine fastened securely to the cylinder block which contains all or a portion of the combustion chamber

23 q. Shaft containing lobes or cams to operate the engine's valves

26 r. Pin that goes through the small end of the connecting rod which also passes through the piston walls; also known as *wrist pin*

22 s. Means for igniting the fuel in the combustion chamber; includes spark plugs, wires, ignition coil, points, condenser, and source of electrical current

24 t. Device for automatically mixing fuel in the proper proportions with air to produce a combustible gas

28 u. Main shaft of the engine which, in conjunction with the connecting rods, changes the reciprocating motion of the pistons into rotary motion

13 v. Space between the electrodes of a spark plug through which the spark jumps

21 w. Control device used to regulate engine speed

25 x. Part of the piston above the rings

27 y. Housing in which the crankshaft and many other parts of the engine operate

(NOTE: Definitions are continued on the next page.)

12. Spark
13. Spark gap
14. Combustion
15. Stroke
16. Exhaust valve
17. Connecting rod
18. Cylinder head
19. Exhaust pipe
20. Gasket
21. Governor
22. Ignition system
23. Camshaft
24. Carburetor
25. Piston head
26. Piston pin
27. Crankcase
28. Crankshaft

15 z. Distance piston travels inside the cylinder

20 aa. Anything used as a packing, such as nonmetallic substance, placed between two metal surfaces to act as a seal

12 bb. Electrical current possessing sufficient pressure to jump through the air from one conductor to another

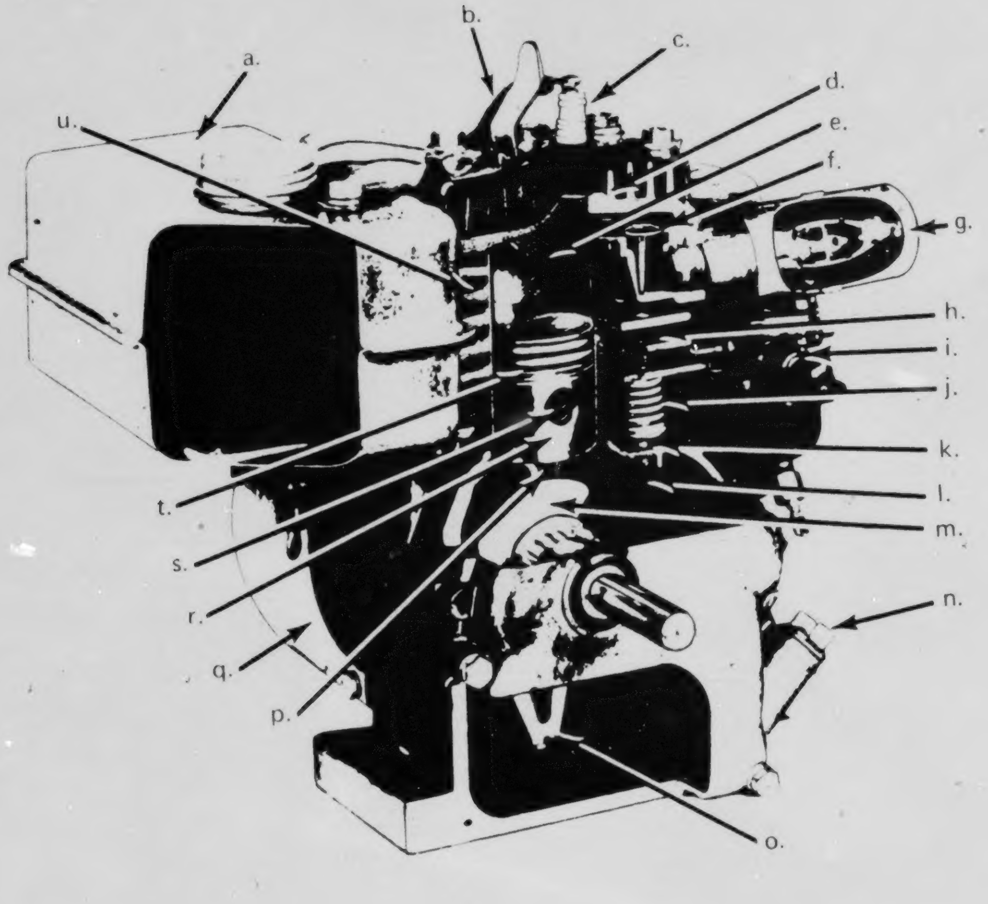
2. List four systems found in a small gasoline engine.

   (NOTE: Any four of the following are acceptable.)

   a. Fuel
   b. Ignition
   c. Lubrication
   d. Starting
   e. Cooling

3. Identify parts of the small horizontal shaft gasoline engine on the next page by writing the correct names in the blanks provided.

   a. Fuel tank
   b. Plug wire
   c. Spark plug
   d. Cylinder head
   e. Cylinder
   f. Valve
   g. Muffler
   h. Valve guide
   i. Carburetor
   j. Valve spring
   k. Push rod or tappet
   l. Camshaft
   m. Crankshaft
   n. Oil fill plug
   o. Crankcase
   p. Connecting rod
   q. Flywheel shroud
   r. Piston
   s. Piston pin
   t. Piston rings
   u. Engine block


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.
m.
n.
o.
p.
q.
r.
s.
t.
u.

4. Identify the following special tools needed in overhauling small engines. Write the correct names in the blanks provided.

a. Flywheel holder

b. Hone

c. Valve seat cutter

d. Valve guide reamer

e. Ring compressor

f. Ring expander

g. Ridge reamer

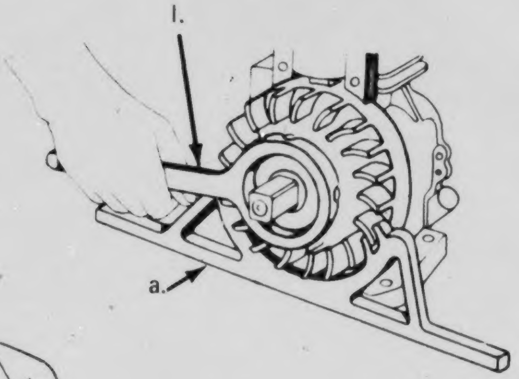
h. Small hole gauge

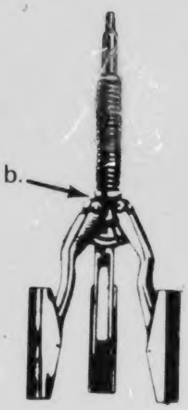
i. Micrometer

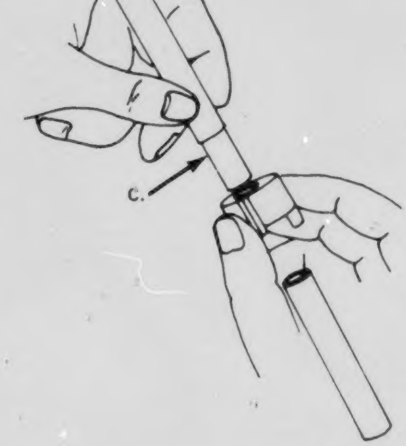
j. Valve spring compressor

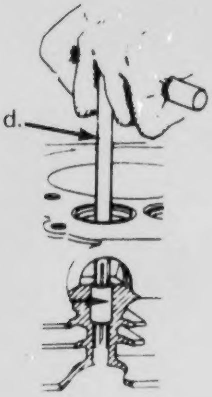
k. Valve seat refacer

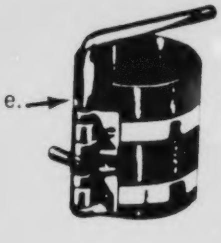
l. Starter clutch wrench

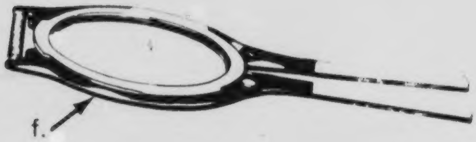


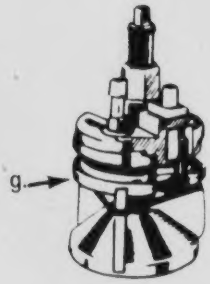


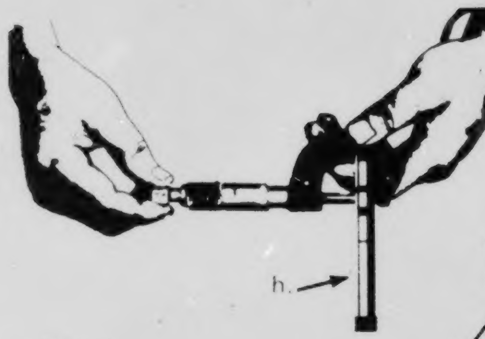








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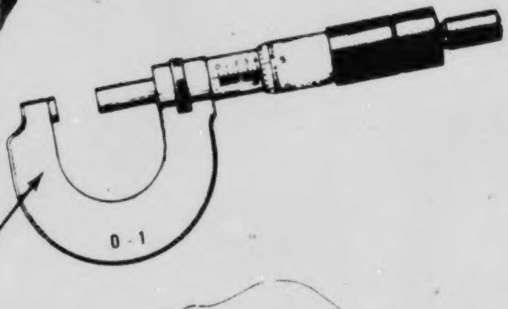
i.
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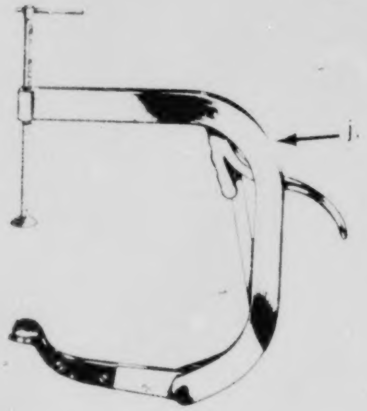
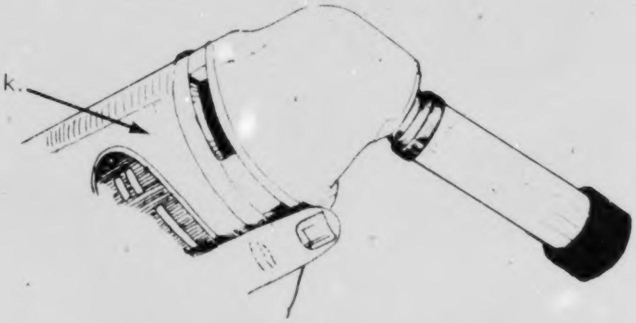

j.

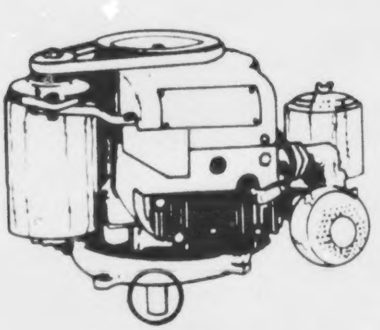

k.

5. List five uses for small gasoline engines.

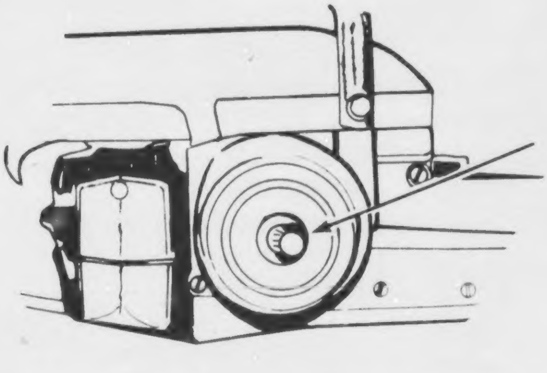
(NOTE: Any five of the following are acceptable.)

a. Post hole digger
b. Irrigation pump
c. Chain saw
d. Small tractor
e. Conveyor
f. Motorcycle
g. Snow blower
h. Rotary tiller
i. Brush cutter
j. Lawn mower
k. Lawn edger
l. Outboard motor
m. Air compressor
n. Sprayer
o. Generator
p. Concrete vibrator
q. Concrete surfacer

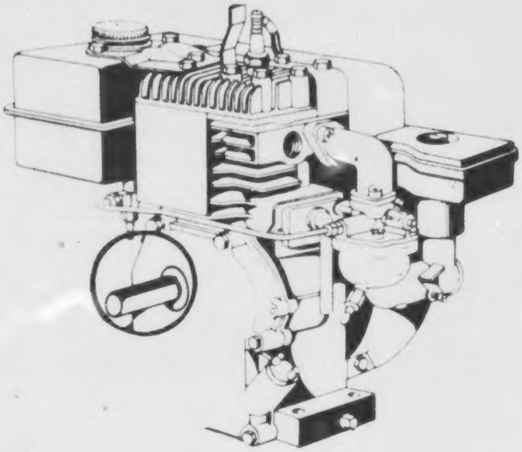
6. Identify the basic operating positions of small gasoline engines by writing the positions in the blanks provided.



a. Vertical crankshaft



b. Multiposition crankshaft



c. Horizontal crankshaft

7. List five items found on an engine nameplate.

   (NOTE: Any five of the following are acceptable.)

   a. Make of engine

   b. Model number or name of engine

   c. Serial number

   d. Type number

   e. Specification number

   f. Size

   g. RPM

8. State the importance of being able to read an engine nameplate.

   Provides information for replacement parts or service

9. Describe the differences between two-stroke and four-stroke cycle engines.

   a. Number of power strokes per crankshaft revolution

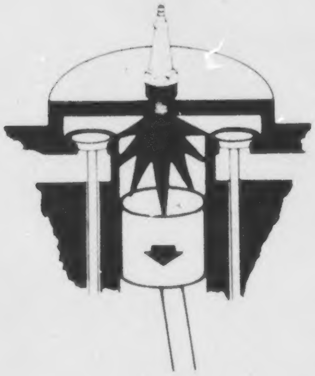
   b. Method of getting fuel-air mixture into combustion chamber

   c. Method of exhaust

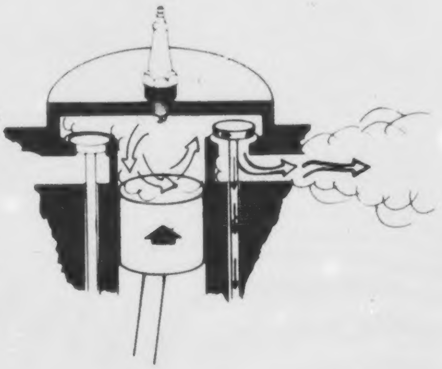
   d. Method of lubricating the internal parts

10. Identify the strokes of a four-stroke cycle engine and a two-stroke cycle engine by writing the correct names in the blanks provided.

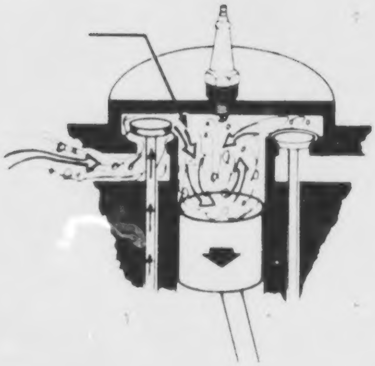
a. Four-stroke cycle engine



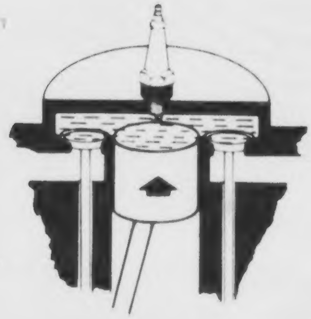
1) Power



2) Exhaust

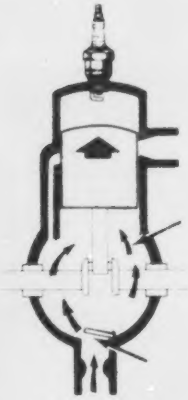


3) Intake

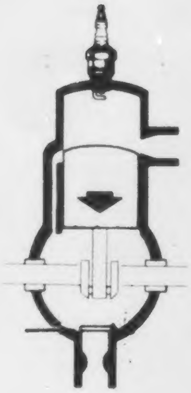


4) Compression

b. Two-stroke cycle engine



1) Intake-Compression



2) Power-Exhaust

11. Identify the parts of a valve by writing the correct names in the blanks provided.

a. Head

b. Face

c. Neck

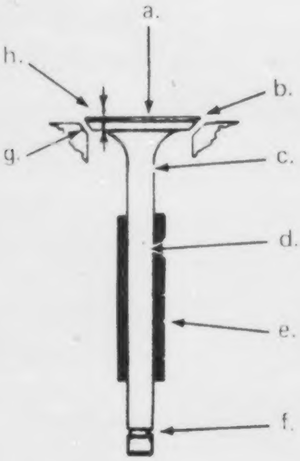
d. Stem

e. Guide

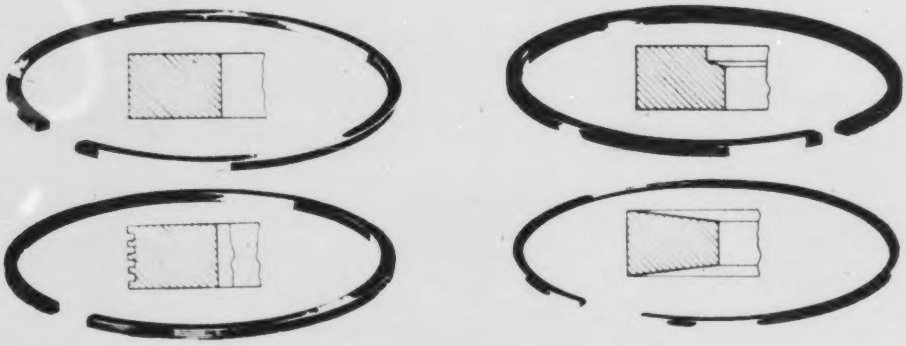
f. Lock groove

g. Seat

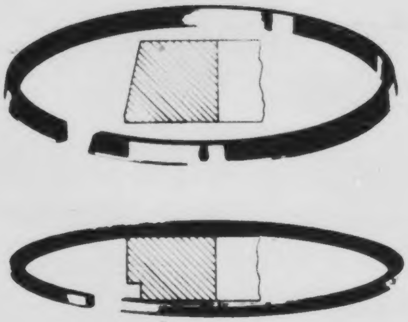
h. Margin



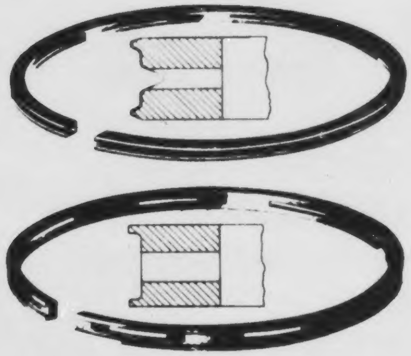
12. Identify the following kinds of rings by writing the correct names in the blanks provided.



a. Compression rings



b. Oil scraper rings



c. Oil control rings

13. Match the kinds of rings to their specific purposes by writing the correct numbers in the blanks provided.

3 a. Regulate the amount of oil going to the compression rings and cylinder wall

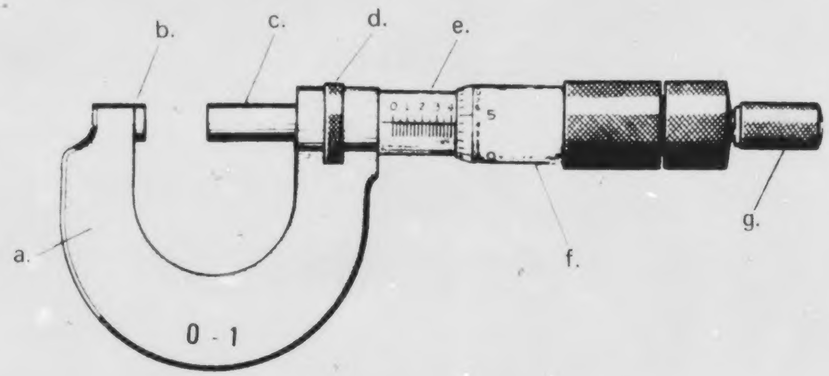
1 b. Make a tight seal against cylinder wall

2 c. Wipe excess oil off cylinder wall as piston moves down

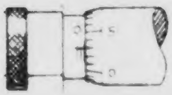
1. Compression rings
2. Oil scraper rings
3. Oil control rings

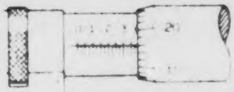
14. Identify the parts of the plain micrometer by writing the correct names in the blanks provided.

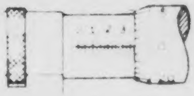
a.	Frame	e.	Sleeve
b.	Anvil	f.	Thimble
c.	Spindle	g.	Ratchet stop
d.	Lock		



15. Read the plain micrometer by writing the readings in the blanks provided.







a. 0.053

b. 0.418

c. 0.350

16. Compelte engine inspection chart.

17. Demonstrate the ability to:

a. Disassemble, inspect, and reassemble a four-stroke cycle engine.

b. Disassemble, inspect, and reassemble a two-stroke cycle engine.

c. Reface valves and valve seats.

d. Replace rings.

(NOTE: Activities 16-17 should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to select from a list the components of the primary and secondary ignition circuits. The student should be able to identify the parts of a battery-powered ignition system and components of a distributor. The student should be able to check the condition of a distributor, replace breaker points and condenser, and adjust breaker points. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the ignition system to the proper definitions.
2. Explain in writing the purpose of the ignition system.
3. Select from a list the components of the primary and secondary ignition circuits.
4. Identify the parts of a battery-powered ignition system.
5. Identify the components of a distributor.
6. List reasons for badly burned points.
7. Demonstrate the ability to:
    a. Check the condition of the distributor.
    b. Replace breaker points and condenser.
    c. Adjust breaker points.

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Give test.

II. Unit references:

   A. American Association for Instructional Materials. *Tractor Maintenance.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

   B. Henderson, W. Charles. *Auto Mechanics: Instructional Units.* Stillwater: Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1971.

   C. *Fundamentals of Service: Electrical Systems.* Moline, Illinois: Deere and Company, 1972.

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Battery--Source of electrical power

   B. Ignition switch--Opens and closes the primary circuit from battery to the contact points

   C. Resistance unit--Reduces voltage in the primary circuit to protect the contact points

   D. Ignition coil--Transforms low voltage into high voltage necessary to jump the spark plug gap

   E. Contact points--Make and break the primary circuit to allow the coil to produce high voltage at the spark plugs

   F. Condenser--Stores extra current as the contact points open to prevent arcing and burning

   G. Distributor--Contains the contact points and condenser; distributes the high voltage current from the coil to the proper cylinder

   H. Breaker cam--Opens and closes the contact points

   I. Spark-advance mechanisms--Regulate the timing of the high voltage circuit for best ignition during all speed and load conditions

   J. Rotor--Takes the high voltage current from the coil and directs it to the correct cylinder

   K. Distributor cap--Holds the coil and spark plug wires in a sequence and provides a cover for the distributor

   L. Spark plug--Provides a spark gap inside the engine cylinder to ignite the fuel-air mixture

   M. Primary ignition wire--Carries low voltage from the battery to the primary side of the ignition coil (light wire)

   N. Secondary ignition wire--Carries high voltage from the secondary side of the coil to the spark plug (heavily insulated wire)

II. Purpose of the ignition system--To produce high voltage current to ignite the fuel-air mixture in the engine cylinders

INFORMATION SHEET

III. Ignition system circuits

- A. Primary--Low voltage circuit (Transparency 1)
  1. Battery
  2. Ignition switch
  3. Resistance unit
  4. Primary winding of the coil
  5. Contact points
  6. Condenser
  7. Low voltage wire that connects the units
- B. Secondary--High voltage circuit (Transparency 2)
  1. Secondary winding of the coil
  2. Distributor cap
  3. Rotor
  4. Spark plug
  5. High voltage wire that connects the units

IV. Parts of a battery-powered ignition system (Transparency 3)

- A. Ignition switch
- B. Battery
- C. Ignition coil
- D. Distributor
- E. Spark plugs
- F. Spark-plug wires

V. Distributor components (Transparency 4)

- A. Distributor cap
- B. Rotor

INFORMATION SHEET

C. Distributor cam

D. Condenser

E. Advance mechanism

F. Distributor drive gear

G. Drive shaft

H. Distributor housing

I. Breaker plate

J. Breaker lever

VI. Reasons for badly burned points

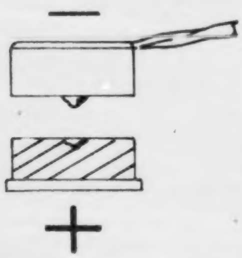
A. Oil or foreign material on the contact surfaces

B. Contact-point gap adjustment that is either too wide, too close, or points that are out of alignment

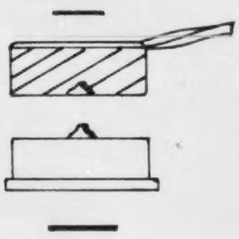
C. Defective condenser

(NOTE: If the condenser is not working properly or is not of the proper capacity for your ignition system, there will be a cone-shaped deposit of metal on one point and a cone-shaped pit on the other.)

Example:



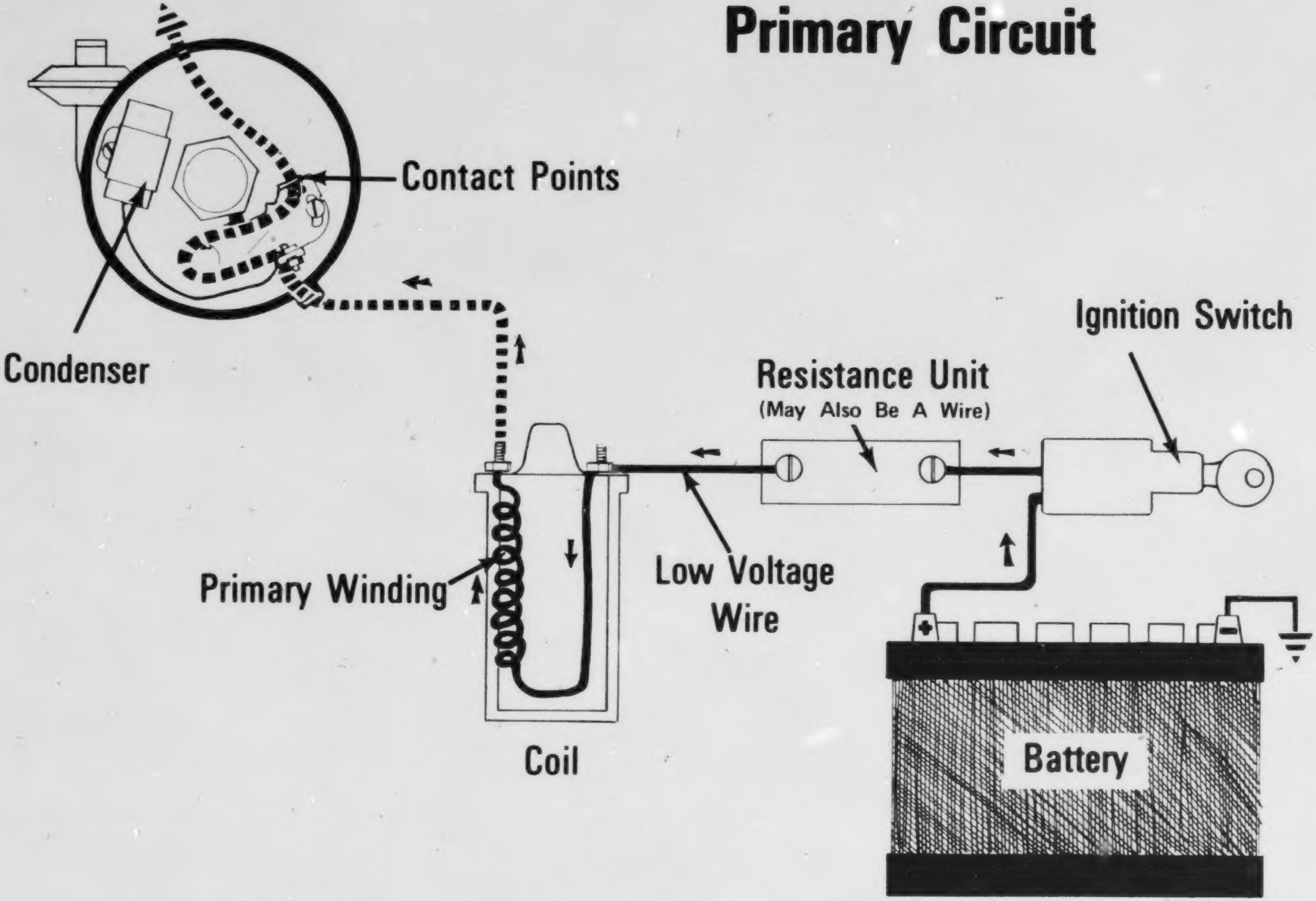
Capacity Too High



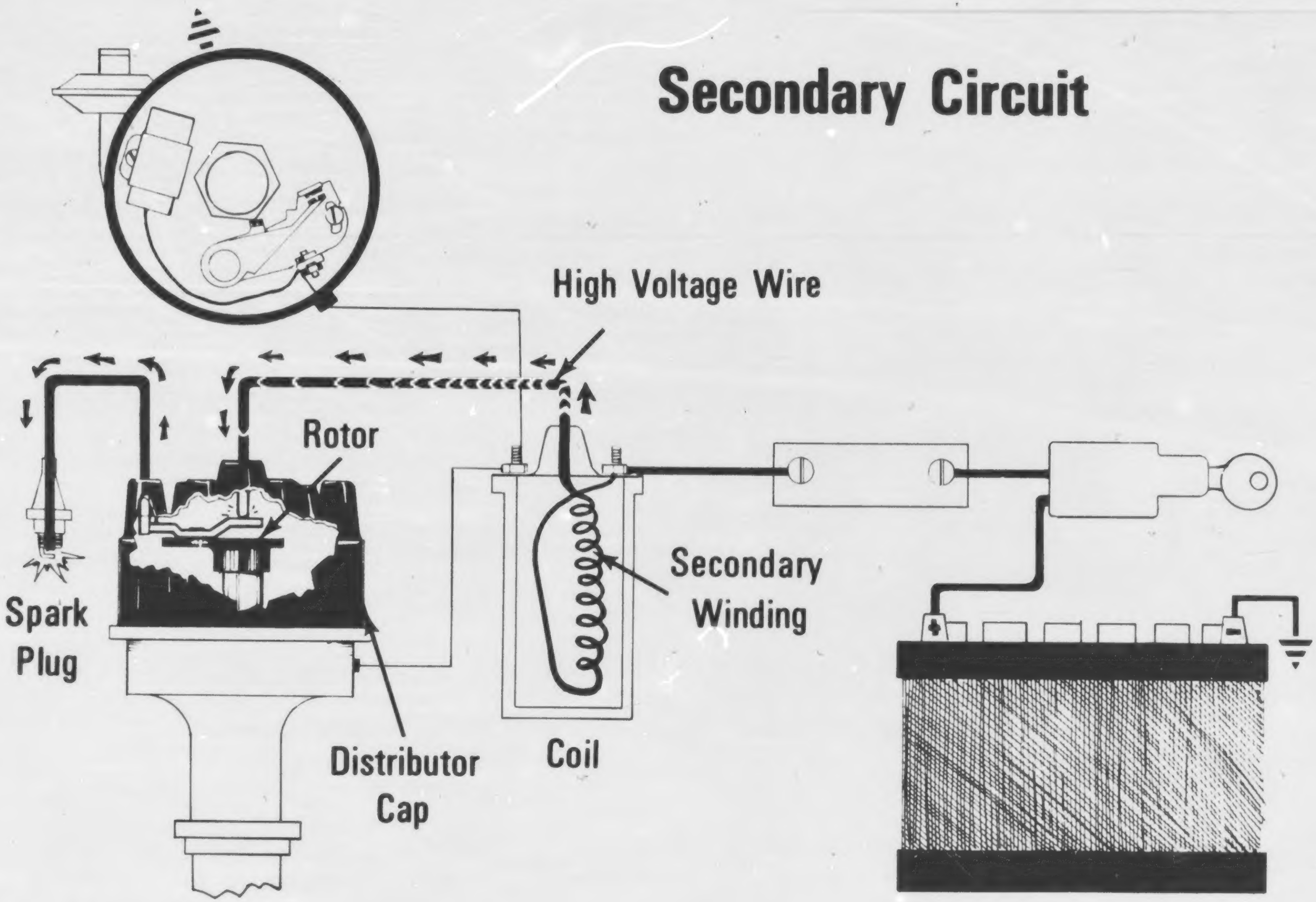
Capacity Too Low

(NOTE: Check tightness of screw that holds the condenser. This screw is also ground connection and must be tight.)

Primary Circuit

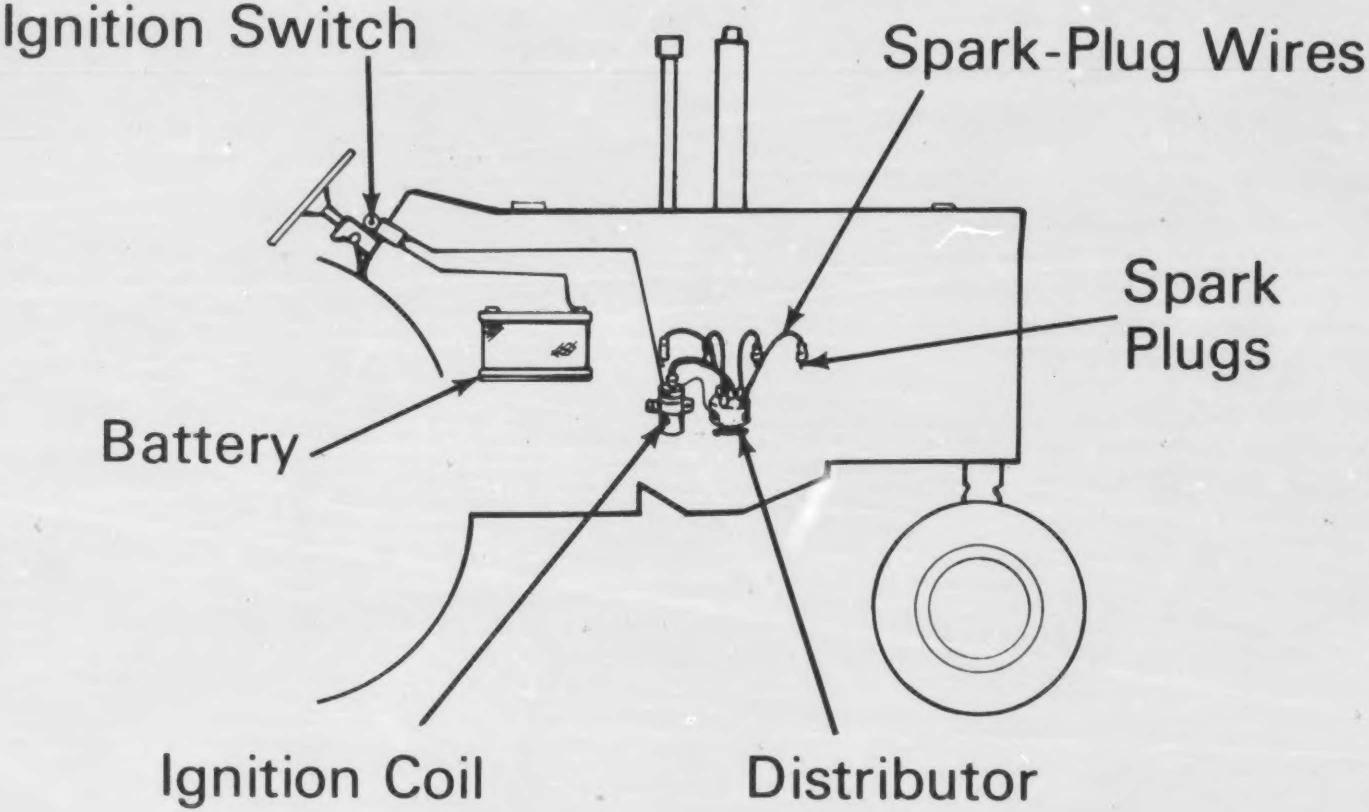

Contact Points
Condenser
Ignition Switch
Resistance Unit
(May Also Be A Wire)
Primary Winding
Low Voltage Wire
Coil
Battery

Secondary Circuit

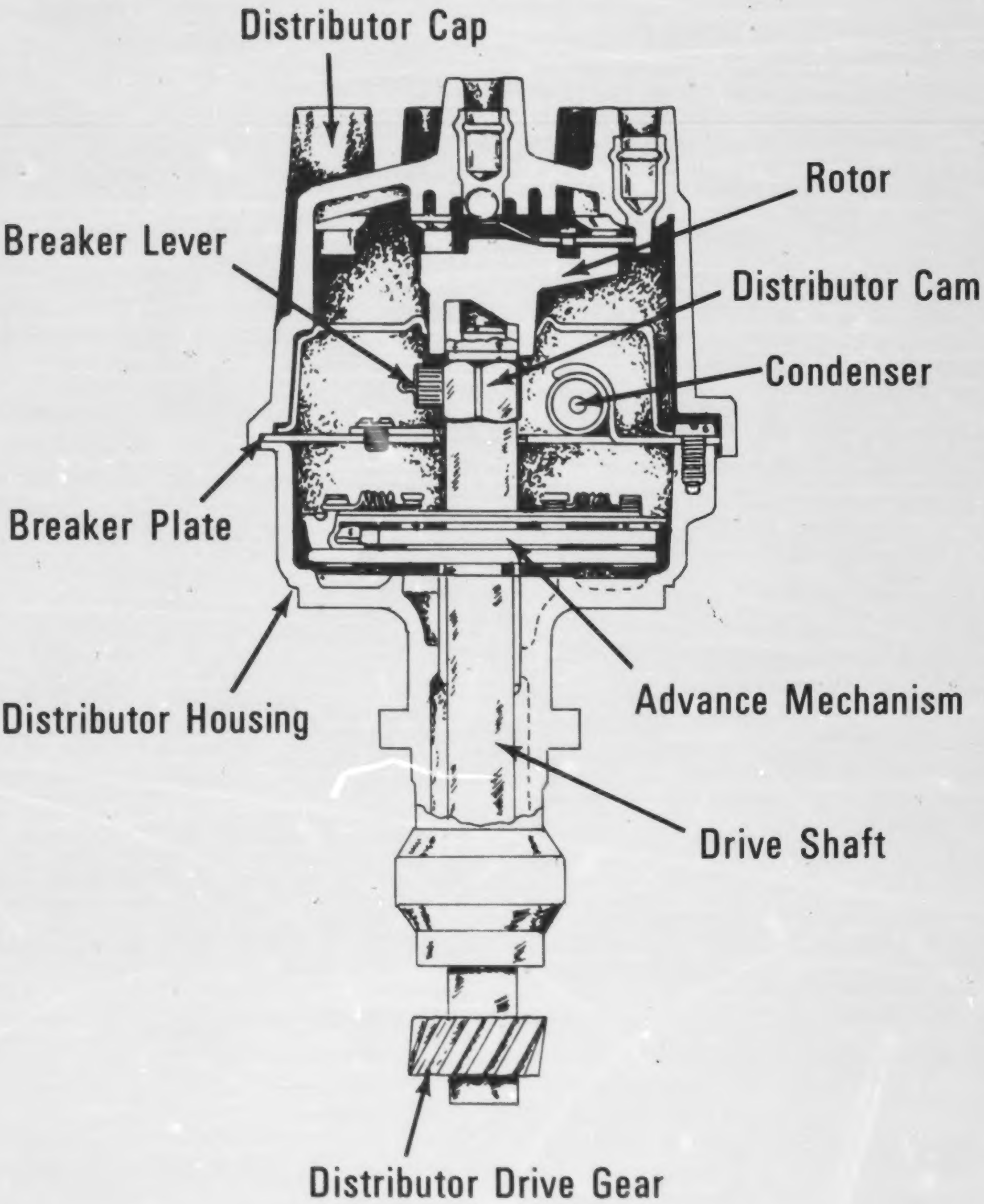

High Voltage Wire
Rotor
Spark Plug
Distributor Cap
Coil
Secondary Winding
+
-

AgM - 175-C

Battery-Powered Ignition System


Ignition Switch
Spark-Plug Wires
Spark Plugs
Battery
Ignition Coil
Distributor

Distributor Components


Distributor Cap
Rotor
Breaker Lever
Distributor Cam
Condenser
Breaker Plate
Advance Mechanism
Distributor Housing
Drive Shaft
Distributor Drive Gear

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

JOB SHEET #1--CHECK THE CONDITION OF THE DISTRIBUTOR

I. Tools and materials

- A. Screwdriver
- B. End wrenches
- C. Ignition file
- D. Clean rags
- E. Small pan of cleaning solvent

II. Procedure

A. Remove dirt from outside surface of distributor and cap

(NOTE: Use a dry cloth or if necessary a small amount of cleaning solvent. Do not use water; it may cause short circuiting.)

B. Remove cap and clean inner surfaces; leave wires connected

(NOTE: Use a clean dry cloth to remove carbon, dust, moisture, or oil deposits.)

C. Check distributor cap for chips or cracks

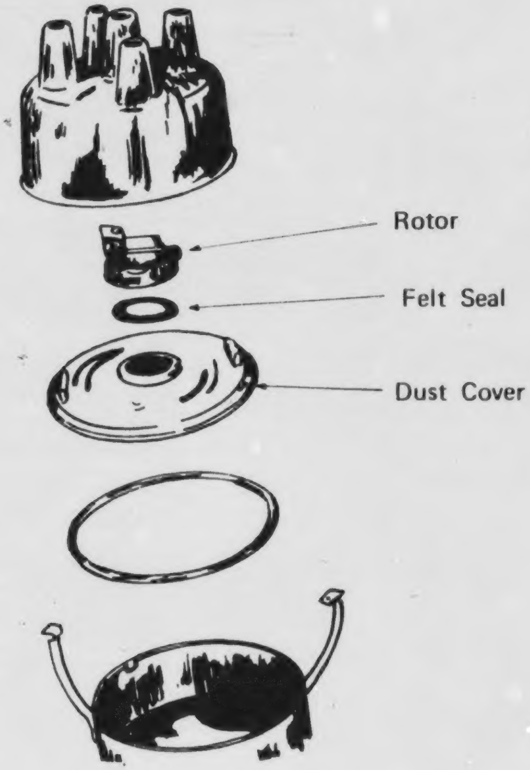
(NOTE: If cap is cracked, replace with a new one. Also check condition of carbon button in center of cap. If it shows excessive wear, chips, or cracks, get a new distributor cap.)

JOB SHEET #1

D. Remove distributor arm (rotor) and clean (Figure 1)

(NOTE: Pull the distributor arm or rotor up or out, if mounted horizonally, from the end of the shaft. Wipe the rotor arm clean with a dry cloth and inspect for cracks or excessive burning of the metal strip. If top of metal strip is badly burned, replace the old rotor with a new one.)

FIGURE 1



E. Remove dust cover, if one is used, and check condition of felt seal

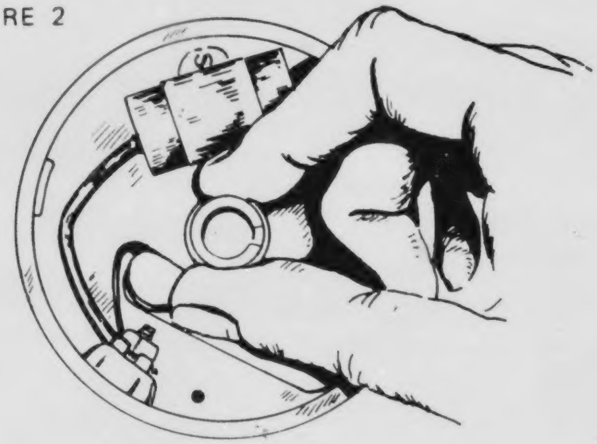
(NOTE: If seal is worn, dirt may enter the breaker compartment and cause rapid wear of cam lobes.)

JOB SHEET #1

F. Check the centrifugal-advance mechanism (Figure 2)

(NOTE: Turn distributor shaft in direction of normal rotation. It should rotate for a short distance as the weights move outward. The springs should return it to the original position when released. If it does not work properly, have a service man check it.)

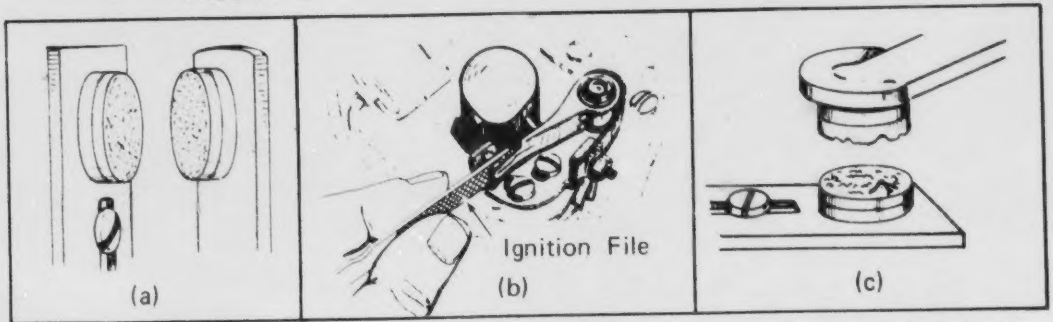
FIGURE 2



G. Check condition of breaker points

(NOTE: If the contact points are rough but show only slight pitting and metal deposits, smooth with an ignition file. The points do not need to be completely smooth with all pits removed. Blow out the dust after you have completed the filing. See Figure 3.)

FIGURE 3



(a) Contact points that are slightly burned or pitted may be (b) smoothed with an ignition file. (c) Badly pitted points should be replaced with new ones.

H. Reassemble distributor in reverse order from the above listed steps

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

JOB SHEET #2--REPLACE BREAKER POINTS AND CONDENSER

I. Tools and materials

  A. Screwdriver

  B. Multi-purpose grease

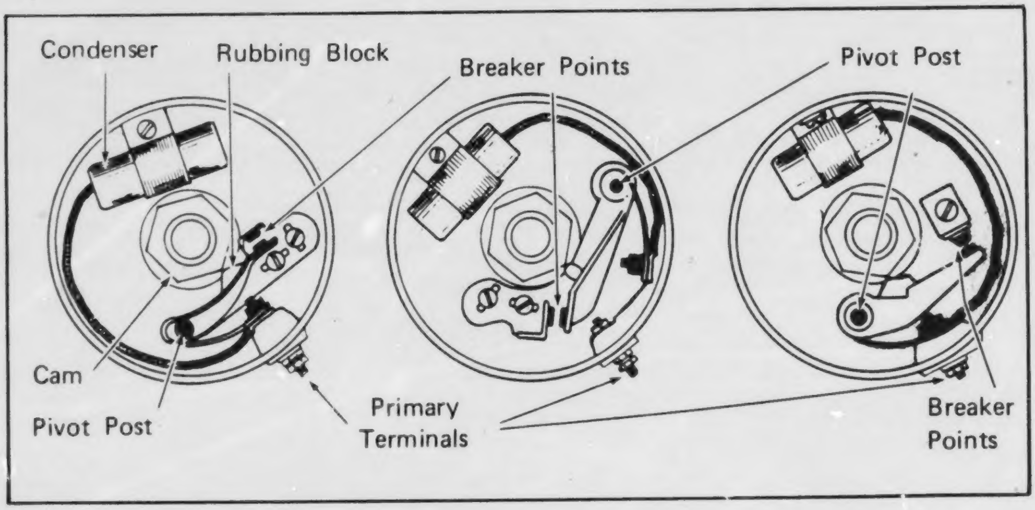
  C. Small amount of SAE-10 crankcase oil

  D. Clean rags

II. Procedure

  A. Remove breaker arm and spring (Figure 1)

FIGURE 1

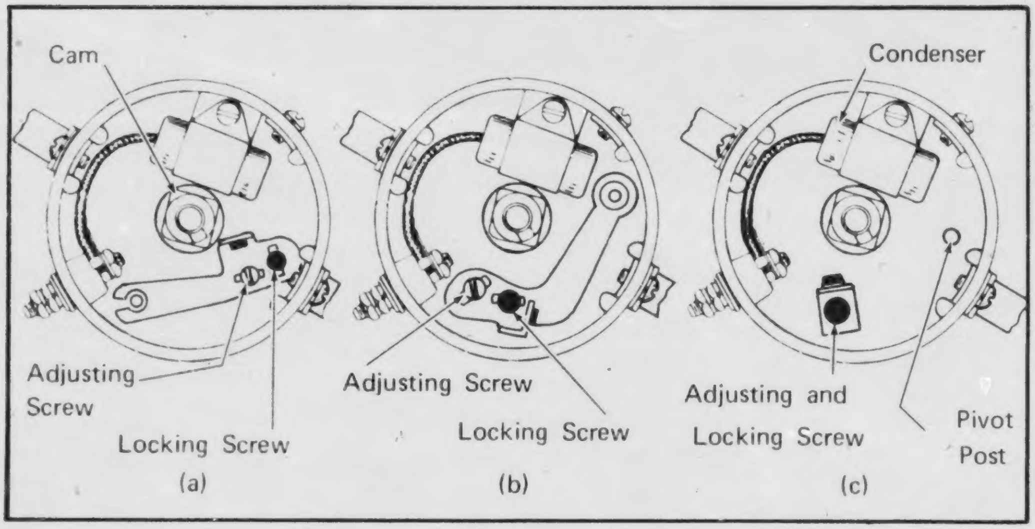

Condenser
Rubbing Block
Breaker Points
Pivot Post
Cam
Pivot Post
Primary Terminals
Breaker Points

JOB SHEET #2

B. Remove stationary breaker point and bracket (Figure 2)

(NOTE: On most distributors one end of the breaker-point bracket is held by the same pivot pin that held the breaker arm. The other end is sometimes held by a locking screw. See Figures 2a and 2b. The second screw is for adjusting the position of the points and is called an "eccentric screw" or "adjusting screw." On others, the bracket and breaker point are held by the screw as in Figure 2c. With this type the hole in the bracket is slotted so the breaker point can be adjusted to the proper position.)

FIGURE 2



(a) (b) (c)

C. Remove condenser

D. Clean, then lubricate, cam with petroleum jelly or multi-purpose grease

(NOTE: Use only enough for a thin film on the cam lobes. This avoids getting it on the breaker points, causing them to burn. A very small amount greatly reduces wear on the rubbing block and cam.)

E. Replace condenser

(NOTE: Make sure all connections are tight and are in proper alignment.)

F. Install new points in reverse order

(NOTE: Apply a drop of SAE-10 crankcase oil around the contact point pivot post before installing new points. See Figure 2c. Be sure electrical connections are tight.)

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

JOB SHEET #3--ADJUST BREAKER POINTS

I. Tools and materials

   A. Screwdriver

   B. Thickness gauge

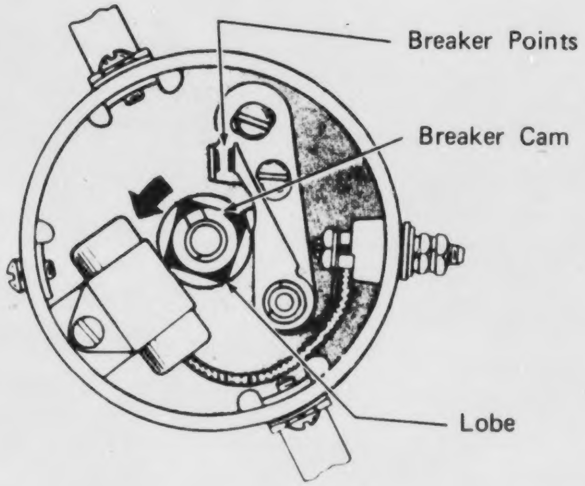
   C. Clean rags

   D. Smooth paper strip

II. Procedure

   A. Turn engine until cam opens breaker points to widest position (Figure 1)

FIGURE 1

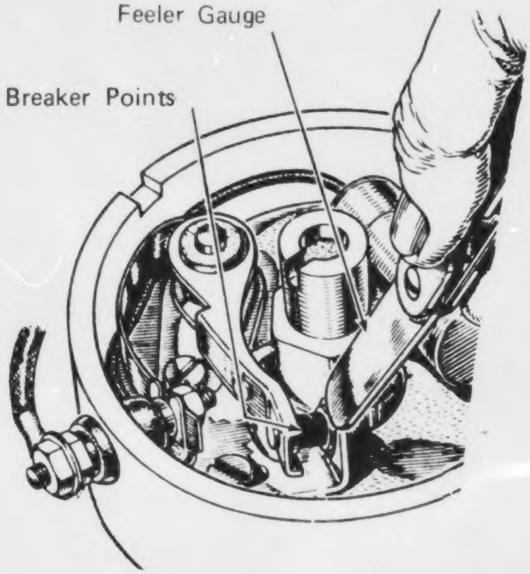

Breaker Points
Breaker Cam
Lobe

JOB SHEET #3

B. Check points for proper spacing (Figure 2)

(NOTE: Use a feeler gauge to determine thickness recommended for your tractor. This may vary from 0.010" to 0.028". The proper width gap is provided when there is a slight drag on the feeler gauge as you pull it between the contact points. If adjustment is needed, proceed with step C. Make sure feeler gauge is free of dirt.)

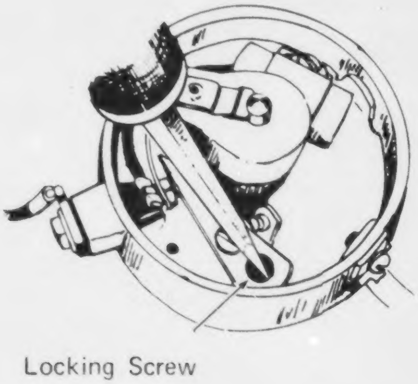
FIGURE 2



(CAUTION: Do not touch point contact surface. This will cause contact surface to corrode.)

C. Loosen locking screw on bracket that provides adjustment (Figure 3)

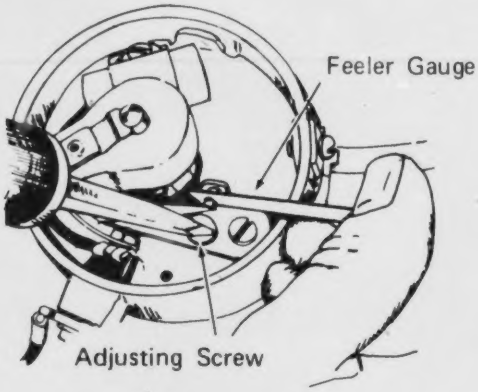
FIGURE 3



JOB SHEET #3

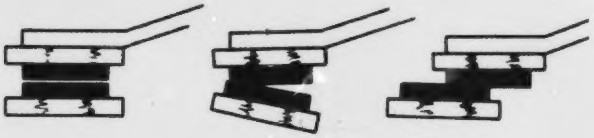
D. Adjust points for proper spacing and alignment (Figure 4)

FIGURE 4



(NOTE: Be sure the breaker-point faces fit together squarely. See Figure 5.)

FIGURE 5



(a) (b) (c)

(a) Breaker points should fit together squarely to keep down wear.

(b) and (c) Only partial contact causes arcing and uneven wear.

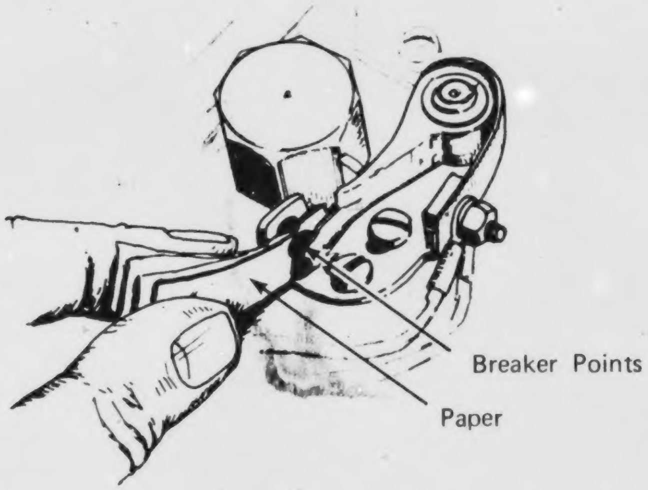
E. Lock breaker point in position with lock screw

JOB SHEET #3

F. Recheck gap between points and wipe points clean (Figure 6)

(NOTE: Run a strip of paper or a clean cloth between the contacts to remove any grease or dirt particles. A crisp dollar bill may be used to clean points.)

FIGURE 6



SERVICING TRACTOR IGNITION SYSTEM
UNIT III

TEST

NAME ______________________ SCORE ______________

1. Match the terms on the right to the proper definitions by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

______a. Carries low voltage from the battery to the primary side of the ignition coil (light wire)

______b. Holds the coil and spark plug wires in a sequence and provides a cover for the distributor

______c. Regulate the timing of the high voltage circuit for best ignition during all speed and load conditions

______d. Contains the contact points and condenser; distributes the high voltage current from the coil to the proper cylinder

______e. Make and break the primary circuit to allow the coil to produce high voltage at the spark plugs

______f. Reduces voltage in the primary circuit to protect the contact points

______g. Source of electrical power

______h. Opens and closes the primary circuit from battery to the contact points

______i. Transforms low voltage into high voltage necessary to jump the spark plug gap

______j. Stores extra current as the contact points open to prevent arcing and burning

______k. Opens and closes the contact points

1. Battery
2. Ignition switch
3. Resistance unit
4. Ignition coil
5. Contact points
6. Condenser
7. Breaker cam
8. Spark-advance mechanisms
9. Rotor
10. Distributor cap
11. Spark plug
12. Primary ignition wire
13. Secondary ignition wire
14. Distributor

_____l. Takes the high voltage current from the coil and directs it to the correct cylinder

_____m. Provides a spark gap inside the engine cylinder to ignite the fuel-air mixture

_____n. Carries high voltage from the secondary side of the coil to the spark plug (heavily insulated wire)

2. Explain in writing the purpose of the ignition system.

____

____

____

3. Select from the list below the components of the primary and secondary ignition circuits. Place an "X" by the correct components.

a. Primary--Low voltage circuit

_____1) Battery

_____2) Rotor

_____3) Ignition switch

_____4) Spark plug

_____5) Contact points

_____6) Condenser

b. Secondary-High voltage circuit

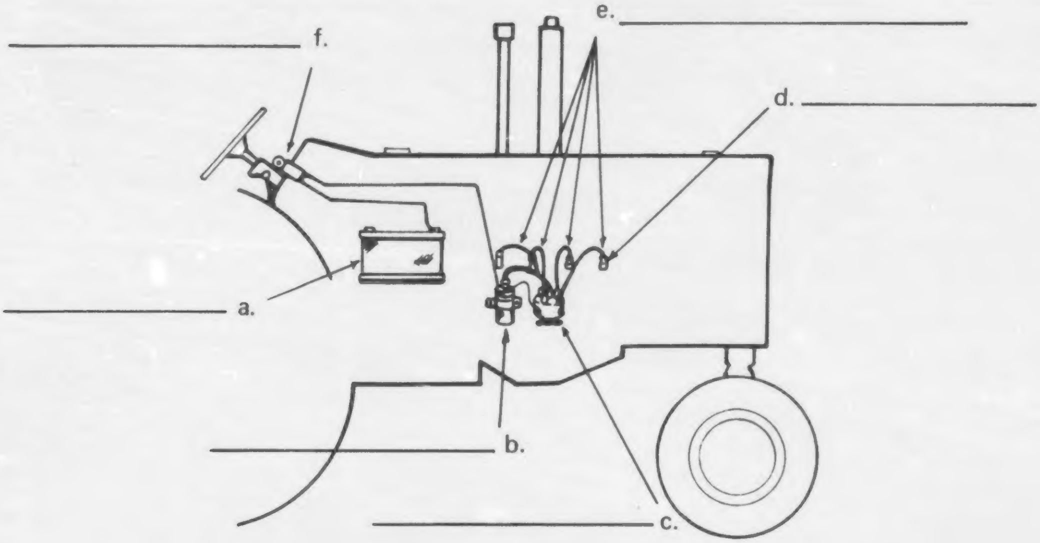
_____1) Secondary winding of the coil

_____2) Distributor cap

_____3) Resistance unit

_____4) Rotor

4. Identify the parts of a battery-powered ignition system.



5. Identify the components of the distributor by writing the correct components in the blanks provided.

a. ____

b. ____

c. ____

d. ____

e. ____

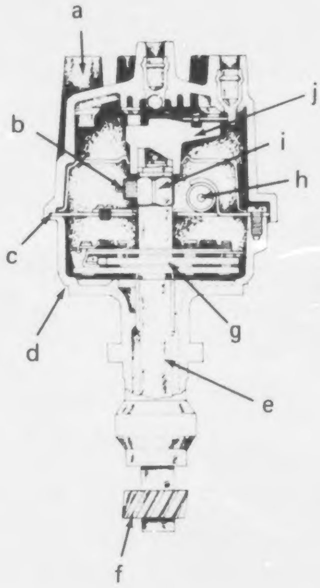
f. ____

g. ____

h. ____

i. ____

j. ____



6. List two reasons for badly burned points.

   a. ____

   b. ____

7. Demonstrate the ability to:

   a. Check the condition of the distributor.

   b. Replace breaker points and condenser.

   c. Adjust breaker points.

   (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR IGNITION SYSTEM
UNIT III

ANSWERS TO TEST

1. Match the terms on the right to the proper definitions by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

12 a. Carries low voltage from the battery to the primary side of the ignition coil (light wire)

10 b. Holds the coil and spark plug wires in a sequence and provides a cover for the distributor

8 c. Regulate the timing of the high voltage circuit for best ignition during all speed and load conditions

14 d. Contains the contact points and condenser; distributes the high voltage current from the coil to the proper cylinder

5 e. Make and break the primary circuit to allow the coil to produce high voltage at the spark plugs

3 f. Reduces voltage in the primary circuit to protect the contact points

1 g. Source of electrical power

2 h. Opens and closes the primary circuit from battery to the contact points

4 i. Transforms low voltage into high voltage necessary to jump the spark plug gap

6 j. Stores extra current as the contact points open to prevent arcing and burning

7 k. Opens and closes the contact points

1. Battery
2. Ignition switch
3. Resistance unit
4. Ignition coil
5. Contact points
6. Condenser
7. Breaker cam
8. Spark-advance mechanisms
9. Rotor
10. Distributor cap
11. Spark plug
12. Primary ignition wire
13. Secondary ignition wire
14. Distributor

__9__ l. Takes the high voltage current from the coil and directs it to the correct cylinder

__11__ m. Provides a spark gap inside the engine cylinder to ignite the fuel-air mixture

__13__ n. Carries high voltage from the secondary side of the coil to the spark plug (heavily insulated wire)

2. Explain in writing the purpose of the ignition system.

   To produce high voltage current to ignite the fuel-air mixture in the engine cylinder

3. Select from the list below the components of the primary and secondary ignition circuits. Place an "X" by the correct components.

   a. Primary--Low voltage circuit

   __X__ 1) Battery

   _____ 2) Rotor

   __X__ 3) Ignition switch

   _____ 4) Spark plug

   __X__ 5) Contact points

   __X__ 6) Condenser

   b. Secondary--High voltage circuit

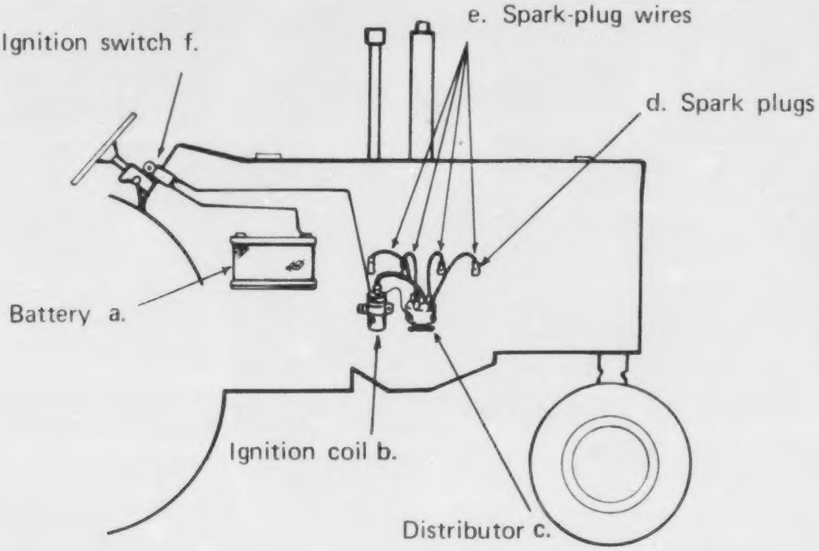
   __X__ 1) Secondary winding of the coil

   __X__ 2) Distributor cap

   _____ 3) Resistance unit

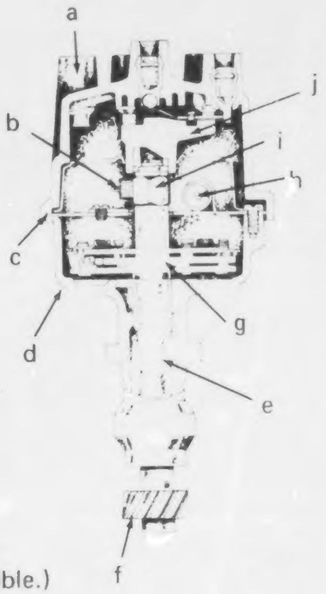
   __X__ 4) Rotor

4. Identify the parts of a battery-powered ignition system.


e. Spark-plug wires
Ignition switch f.
d. Spark plugs
Battery a.
Ignition coil b.
Distributor c.

5. Identify the components of the distributor by writing the correct components in the blanks provided.

 a. Distributor cap
 b. Breaker lever
 c. Breaker plate
 d. Distributor housing
 e. Drive shaft
 f. Distributor drive gear
 g. Advance mechanism
 h. Condenser
 i. Distributor cam
 j. Rotor


a
j
b
i
h
c
g
d
e
f

6. List two reasons for badly burned points.

 (NOTE: Any two of the following are acceptable.)

 a. Oil or foreign material on the contact surfaces
 b. Contact-point gap adjustment that is either too wide, too close, or points that are out of alignment
 c. Defective condenser

7. Demonstrate the ability to:

   a. Check the condition of the distributor.

   b. Replace breaker points and condenser.

   c. Adjust breaker points.

   (NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the cooling system. The student should be able to match the types of corrosion and deposits with the probable causes and demonstrate the ability to flush or clean the cooling system and test the pressure of a cooling system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with servicing the tractor's cooling system to the correct definitions.
2. Identify the parts of a cooling system.
3. List the jobs that the cooling system must perform.
4. Select from a list the reasons a pressure type radiator cap is used with forced circulation cooling systems.
5. Select from a list the reasons a permanent antifreeze solution should be used in a cooling system at all times.
6. List the problems that result when a engine overheats.
7. Match the types of corrosion and deposits found in a cooling system to the probable causes.
8. Name ways to protect a cooling system from rust.
9. Demonstrate the ability to:
    a. Flush or clean the cooling system.
    b. Pressure test the cooling system.

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  G. Give test.

II. Unit references:

A. American Association for Vocational Instructional Materials, Engineering Division. *Tractor Maintenance.* Athens, Georgia: McCall Printing Co./Foote and Davis Division, 1970.

B. *Auto Mechanics Instructional Units.* Stillwater: Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1971.

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

INFORMATION SHEET

I. Terms and definitions (Transparency 1)

   A. Water pump--Centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system

   B. Water jackets--Passages through the block and cylinder head that allow the coolant to circulate around the cylinders, valves, and combustion chambers

   C. Radiator--Device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air

   D. Fan--Device generally mounted on the water pump hub assembly used to pull a large volume of air through the openings in the radiator core

   E. Shroud--Funnel-like structure attached to the radiator and extending around and behind the fan used to make the fan more effective in pulling air through the radiator

   F. Thermostat--Heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator

   G. Pressure cap--Cap which increases the pressure within the cooling system several pounds per square inch, allowing the coolant to circulate at higher temperatures without evaporation or surge loss

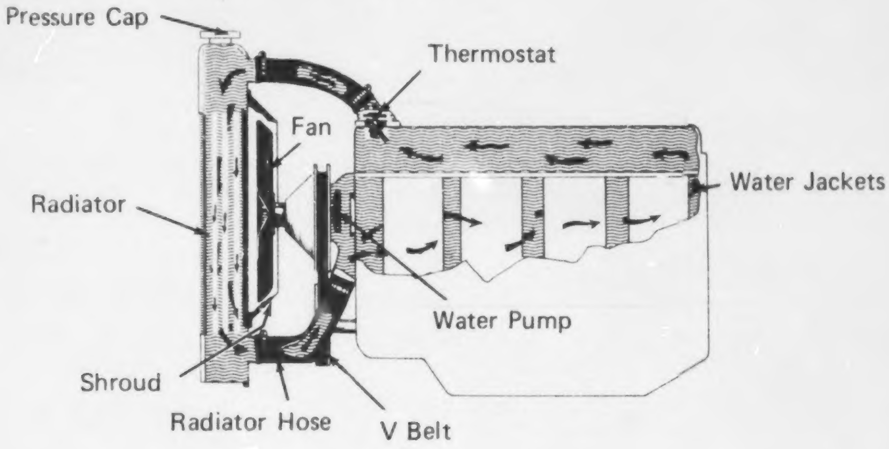
   H. Radiator hose--Hose used to connect the radiator to the engine

   I. V belt--Belt turned by a pulley on the front of the crankshaft used to drive the water pump, fan, and other engine accessories

   J. Inner or internal cooler--Small radiator that helps cool engine oil

INFORMATION SHEET

II. Parts of a cooling system (Transparency 1)



III. Jobs that the cooling system must perform

A. Remove surplus or unwanted heat

B. Maintain an efficient temperature under all operating conditions

C. Bring an engine, when started, up to operating temperature as soon as possible

IV. Reasons a pressure type radiator cap is used with forced circulation cooling systems

A. Makes it possible for the tractor to operate at high temperatures

(NOTE: Water at a temperature of 180°F to 195°F is so hot it tends to vaporize readily. Without a pressure cap, water vapor would be free to pass through the overflow tube and you would probably have to refill the radiator several times a day. With a pressure cap the vapor is held inside the radiator.)

B. Acts as a pressure-release valve (Transparency 2)

(NOTE: If the pressure in the radiator gets above the pressure exerted by the spring, the cap permits air or vapor or both to pass into the upper section and out through the overflow tube.)

C. Vacuum valve fits in the center of the pressure-release valve and allows air to enter the radiator when the coolant cools

(NOTE: Without a vacuum valve, a vacuum would develop when the engine cools causing the radiator hoses to collapse and air leaks to develop around the water-pump shaft and any weak spots in the radiator.)

D. Prevents water from going out overflow tube

INFORMATION SHEET

V. Reasons for using a permanent type antifreeze

   A. Prevents coolant from freezing

   B. Boiling point of permanent antifreeze is higher than water

   C. Reduces the corrosive action of water

VI. Problems that result when an engine overheats

   A. Sticking and burned valves

   B. Cracked engine head or block

   C. Excessive knock

   (NOTE: Excessive knock is a result of hot spots that develop and cause incoming fuel to ignite before the spark plug fires.)

VII. Causes of corrosion and deposits found in a cooling system

   A. Mineral deposits--Result from repeated additions of hard water that contain alkali (lime and/or magnesium) or minerals (iron)

   B. Rust--When water and oxygen are both present, there is a natural tendency for iron parts in the cooling system to rust

   C. Galvanic corrosion--Caused by small electric currents that are set up where two or more different metals are in contact in the cooling system; sometimes called electrolytic corrosion

   (NOTE: This action is similar to that of a flashlight battery in which certain metal parts are gradually eaten away and perforated.)

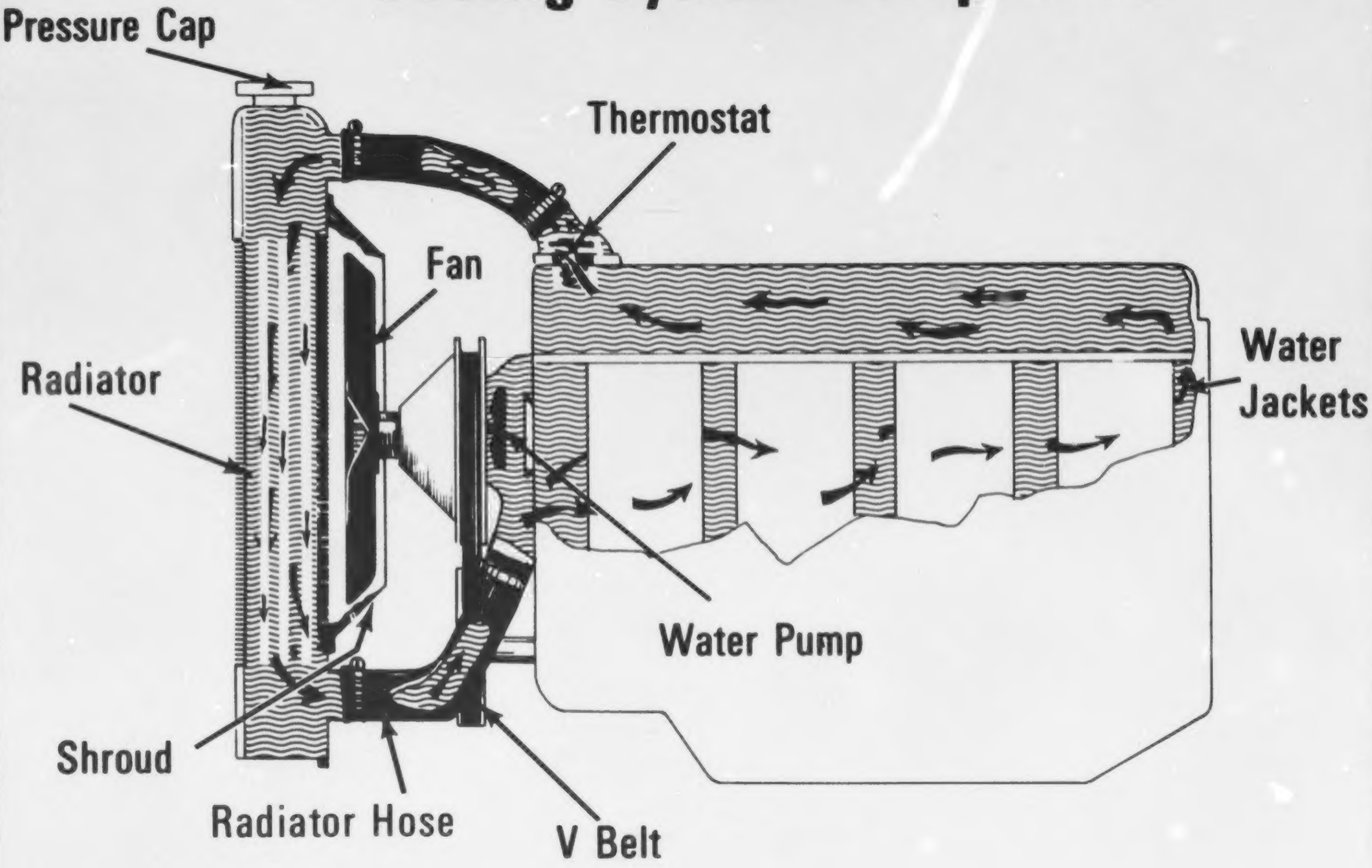
VIII. Protecting a cooling system from rust

   A. Use a chemical inhibitor that combines with the metal surface to give a protective coating

   B. Use a soluble-oil inhibitor which settles out of the water and provides protection by coating the surfaces in the cooling system

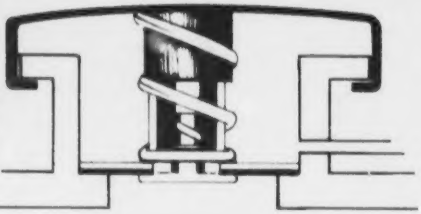
   (NOTE: Some manufacturers include both types of protection in their anti-rusts.)

Cooling System Components


Pressure Cap
Thermostat
Fan
Radiator
Water Jackets
Water Pump
Shroud
Radiator Hose
V Belt

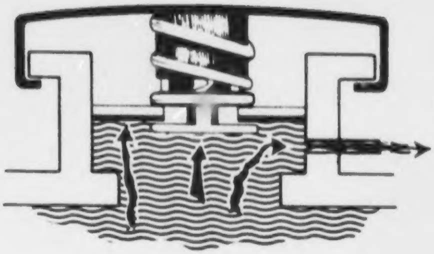
Pressure Type Radiator Caps

Normal Operation



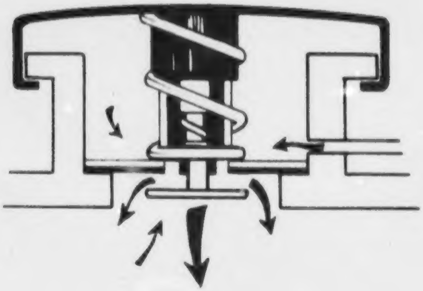
Valves Closed

Excessive Pressure



Pressure Valve Open

Cooling-Off Period



Vacuum Valve Open

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

JOB SHEET #1--FLUSH OR CLEAN THE COOLING SYSTEM

I. Tools and materials

A. Commercial flushing compound

(NOTE: This is used when system is in good condition.)

B. Commercial cooling system cleaner

(NOTE: This is used when there is considerable evidence of scale and rust.)

C. Cardboard or blanket to reduce air flow through radiator

D. Water supply

E. Adjustable pliers

F. Screwdriver

II. Procedure

(NOTE: The procedures are determined by the chemicals being used.)

A. Read the instructions on the container

(NOTE: You may be able to add the contents directly to the present coolant. If antifreeze is in the cooling system, the instructions may indicate that the coolant be drained and replaced with water.)

1. If cleaner or flushing compound is to be added to present coolant, proceed with step B

2. If present coolant should be replaced with water, proceed as follows:

a. Run engine until thoroughly warmed

(NOTE: When engine is warmed enough, the thermostat valve is open and will allow more complete drainage. Cover radiator to be certain engine warms.)

JOB SHEET #1

b. Completely drain cooling system while engine is still warm

(NOTE: Some tractors have only one drain cock but most have two or three, one on the radiator and one or two on the engine block.)

c. Close drain cocks

d. Refill cooling system with water

(NOTE: If engine is hot, allow it to cool; then add water slowly to avoid cracking engine block or head. Allow enough space to add the flushing compound or cleaner without causing the coolant to overflow.)

B. Add flushing compound or cleaner

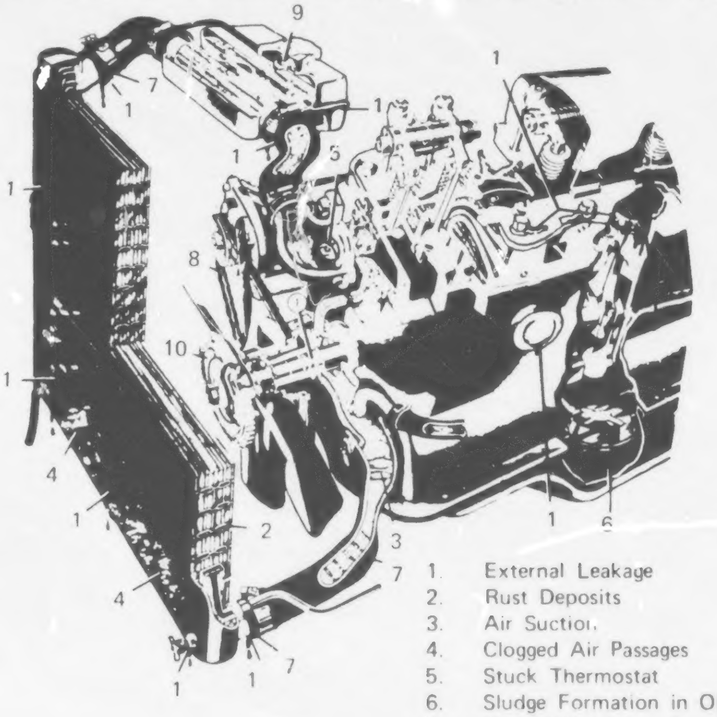
C. Start engine and operate until normal operating temperature is reached

(NOTE: Cover the engine so it will heat quickly and completely. Do not allow the coolant to boil.)

D. Check external condition of cooling system (Figure 1)

(NOTE: Illustration enclosed indicates points that should be checked.)

FIGURE 1



1. External Leakage
2. Rust Deposits
3. Air Suction
4. Clogged Air Passages
5. Stuck Thermostat
6. Sludge Formation in Oil
7. Hose Failure
8. Worn Fan Belt
9. Pressure Cap Leakage
10. Temperature Control Fan Drive

JOB SHEET #1

(NOTE: Most of these checks can be made while the engine is operating. If leak is found that can not be fixed with a new hose or by tightening a hose clamp, the tractor should be taken to a competent repairman.)

E. Completely drain cooling system

F. Use a neutralizer if acid-base cleaner was used

   1. Add neutralizer provided and fill cooling system

   2. Run engine about ten minutes; then drain

   3. Flush cooling system with water

G. Refill with coolant

   1. Use clean soft water and a rust inhibitor or new antifreeze solution with soft water

      (NOTE: Do not use old antifreeze with a new can of rust inhibitor. Because of different chemical compounds used for rust inhibitors the new and old antifreeze inhibitors may offset each other, so neither is effective.)

   2. Refer to the operator's manual for the cooling system capacity of your tractor if you install antifreeze

H. Clean radiator externally by using compressed air or water

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

JOB SHEET #2--PRESSURE TEST THE COOLING SYSTEM

I. Tools and materials--Radiator pressure tester

II. Procedure

A. Remove radiator cap

(CAUTION: Never remove the radiator cap quickly when the engine is hot. If cap must be removed when hot, loosen cap to first stop and leave in this position until all pressure is released. Cap can then be removed safely.)

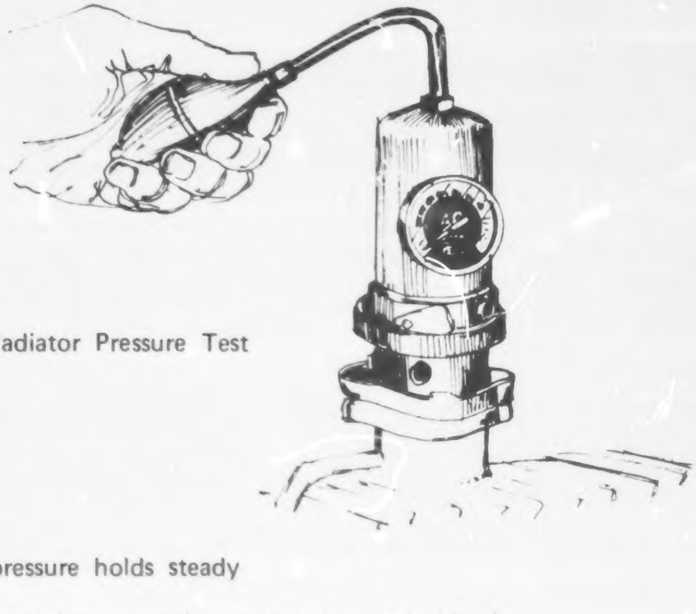
B. Wipe the radiator filler cap seat clean

C. Attach the radiator pressure tester

D. Apply pressure

(NOTE: Pressure applied should not exceed recommended cooling system pressure by more than 1 psi. See Figure 1.)

FIGURE 1



Radiator Pressure Test

E. Make sure pressure holds steady

(NOTE: This indicates cooling system is not leaking.)

JOB SHEET #2

F. Check to see if pressure drops

(NOTE: Check for external leaks, such as hose connections, expansion plugs, water pump, and radiator.)

G. Watch to see if pressure drops, but external leaks are not visible

(NOTE: Remove tester; start and run engine until operating temperature is reached.)

H. Re-attach tester and apply cooling system pressure

I. Increase engine speed to half throttle

J. If pressure needle fluctuates, this indicates a combustion leak

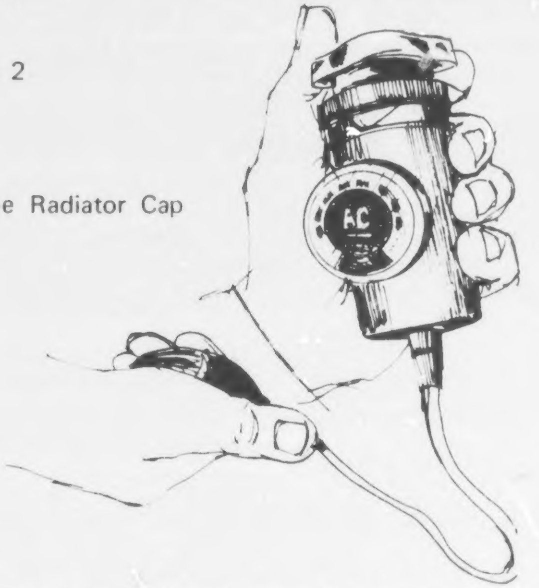
K. If pressure meter needle does not fluctuate, sharply accelerate engine several times and check for a discharge of water from the tailpipe

(NOTE: If an abnormal amount of water is discharged at the tailpipe, this could indicate a cracked block or head or a defective head gasket. Check radiator for loss of coolant on tractors having vertical stack or exhaust.)

L. Test the pressure cap

(NOTE: Use same tester with adapter to test cap. If the cap does not hold the rated pressure, it should be replaced. See Figure 2.)

FIGURE 2



Testing the Radiator Cap

M. Check coolant level and reinstall cap when test is completed

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

TEST

NAME____SCORE____________________

1. Match the terms on the right to the proper definitions on the left. Place the appropriate numbers in the blanks provided. Definitions are continued on the following page.

______a. Centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system

______b. Belt turned by a pulley on the front of the crankshaft used to drive the water pump, fan, and other engine accessories

______c. Heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator

______d. Hose used to connect the radiator to the engine

______e. Cap which increases the pressure within the cooling system several pounds per square inch, allowing the coolant to circulate at higher temperatures without evaporation or surge loss

______f. Funnel-like structure attached to the radiator and extending around and behind the fan used to make the fan more effective in pulling air through the radiator

______g. Passages through the block and cylinder head that allow the coolant to circulate around the cylinders, valves, and combustion chambers

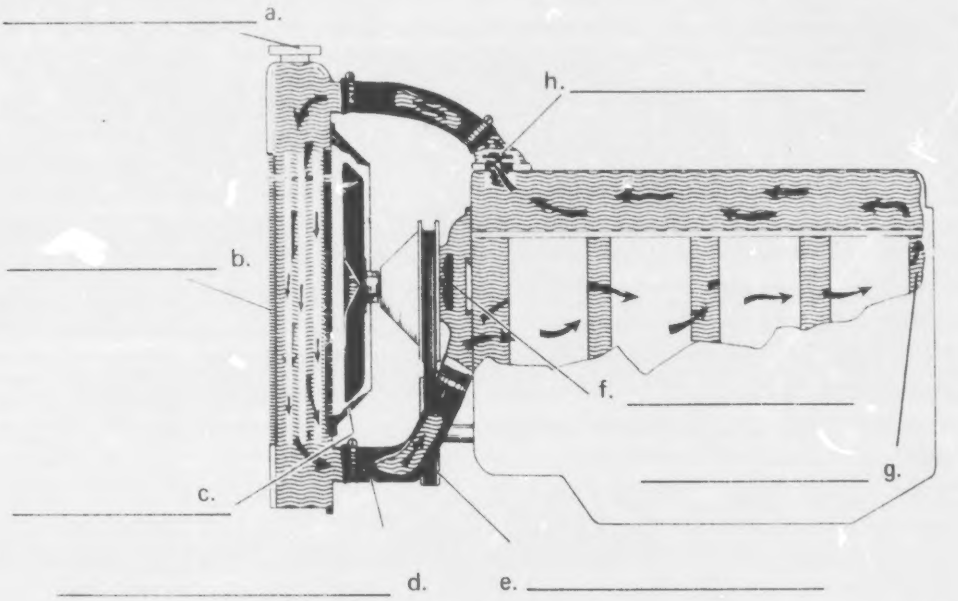
______h. Device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air

1. Water pump
2. Water jackets
3. Radiator
4. Fan
5. Shroud
6. Thermostat
7. Pressure cap
8. Radiator hose
9. V belt
10. Inner or internal cooler

______i. Device generally mounted on the water pump hub assembly used to pull a large volume of air through the openings in the radiator core

______j. Small radiator that helps cool engine oil

2. Identify the parts of a cooling system using the illustration below. Write the correct parts in the blanks provided.



3. List the jobs that the cooling system must perform.

a. ______________________________

b. ______________________________

c. ______________________________

4. Select from the list below the reasons a pressure type radiator cap is used with forced circulation cooling systems. Place an "X" by the proper answers.

______a. Makes it possible for the tractor to operate at a low temperature

______b. Acts as a pressure-release valve

______c. Vacuum valve fits in the center of the pressure-release valve and allows air to enter the radiator when the coolant cools

______d. Prevents water from going out overflow tube

5. Select from the list below the reasons a permanent antifreeze solution should be used at all times in a cooling system. Place an "X" by correct answers.

   ______a. Prevents coolant from freezing

   ______b. Boiling point of permanent antifreeze is lower than water

   ______c. Reduces the corrosive action of water

   ______d. Prevents coolant from boiling

6. List two problems that result when an engine overheats.

   a. ____

   b. ____

7. Match the types of corrosion and deposits on the right to the correct causes of each. Place the appropriate numbers in the blanks provided.

   ______a. When water and oxygen are both present, there is a natural tendency for iron parts in the cooling system to rust

   ______b. Result from repeated additions of hard water that contain alkali (lime and/or magnesium) or minerals (iron)

   ______c. Caused by small electric currents that are set up where two or more different metals are in contact in the cooling system; sometimes called electrolytic corrosion

   1. Galvanic corrosion
   2. Rust
   3. Mineral deposits

8. Name ways to protect a cooling system from rust.

   a. ____

   b. ____

9. Demonstrate the ability to:

   a. Flush or clean the cooling system.

   b. Pressure test the cooling system.

   (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR COOLING SYSTEM
UNIT IV

ANSWERS TO TEST

1. Match the terms on the right to the proper definitions on the left. Place the appropriate numbers in the blanks provided. Definitions are continued on the following page.

__1__ a. Centrifugal pump mounted at the front of the cylinder block to circulate the coolant throughout the cooling system

__9__ b. Belt turned by a pulley on the front of the crankshaft used to drive the water pump, fan, and other engine accessories

__6__ c. Heat controlled valve used in the cooling system to regulate the flow of coolant between the cylinder block and radiator

__8__ d. Hose used to connect the radiator to the engine

__7__ e. Cap which increases the pressure within the cooling system several pounds per square inch, allowing the coolant to circulate at higher temperatures without evaporation or [illegible] loss

__5__ f. Funnel-like structure attached to the radiator and extending around and behind the fan used to make the fan more effective in pulling air through the radiator

__2__ g. Passages through the block and cylinder head that allow the coolant to circulate around the cylinders, valves, and combustion chambers

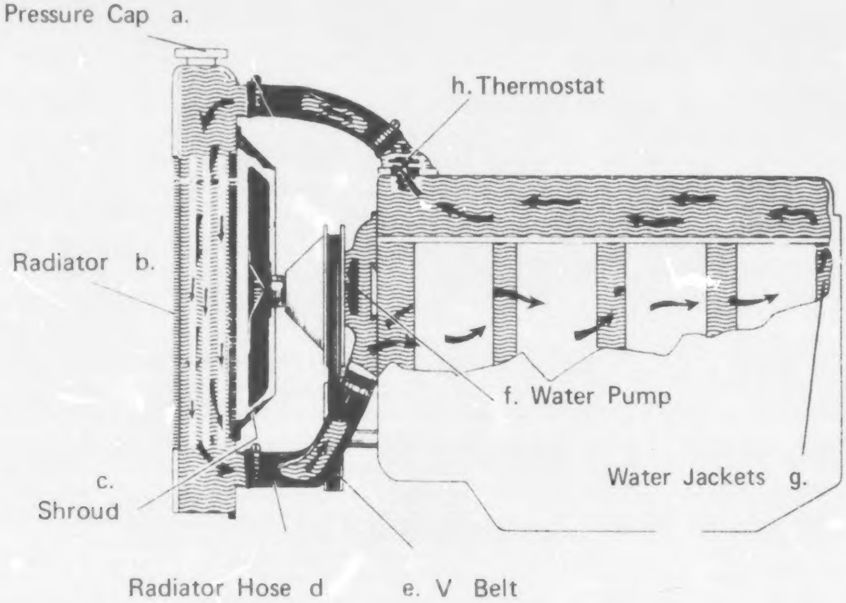
__3__ h. Device for holding a considerable volume of coolant in close contact with a large amount of air so that heat may be transferred from the coolant to the air

1. Water pump
2. Water jackets
3. Radiator
4. Fan
5. Shroud
6. Thermostat
7. Pressure cap
8. Radiator hose
9. V belt
10. Inner or internal cooler

__4__ i. Device generally mounted on the water pump hub assembly used to pull a large volume of air through the openings in the radiator core

__10__ j. Small radiator that helps cool engine oil

2. Identify the parts of a cooling system using the illustration below. Write the correct parts in the blanks provided.



3. List the jobs that the cooling system must perform.

   a. Remove surplus or unwanted heat

   b. Maintain an efficient temperature under all operating conditions

   c. Bring an engine, when started, up to operating temperature as soon as possible

4. Select from the list below the reasons a pressure type radiator cap is used with forced circulation cooling sytems. Place an "X" by the proper answers.

______ a. Makes it possible for the tractor to operate at a low temperature

__X__ b Acts as a pressure-release valve

__X__ c. Vacuum valve fits in the center of the pressure-release valve and allows air to enter the radiator when the coolant cools

__X__ d. Prevents water from going out overflow tube

5. Select from the list below the reasons a permanent antifreeze solution should be used at all times in a cooling system. Place an "X" by correct answers.

X a. Prevents coolant from freezing

_____ b. Boiling point of permanent antifreeze is lower than water

X c. Reduces the corrosive action of water

_____ d. Prevents coolant from boiling

6. List two problems that result when an engine overheats.

(NOTE: Any two of the following are acceptable.)

a. Sticking and burned valves

b. Cracked engine head or block

c. Excessive knock

7. Match the types of corrosion deposits on the right with the correct causes of each. Place the appropriate numbers in the blanks provided.

2 a. When water and oxygen are both present, there is a natural tendency for iron parts in the cooling system to rust

3 b. Result from repeated additions of hard water that contain alkali (lime and/or magnesium) or minerals (iron)

1 c. Caused by small electric currents that are set up where two or more different metals are in contact in the cooling system; sometimes called electrolytic corrosion

1. Galvanic corrosion
2. Rust
3. Mineral deposits

8. Name ways to protect a cooling system from rust.

a. Use a chemical inhibitor that combines with the metal surface to give a protective coating

b. Use a soluble-oil inhibitor which settles out of the water and provides protection by coating the surfaces in the cooling system

9. Demonstrate the ability to:

a. Flush or clean the cooling system.

b. Pressure test the cooling system.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR FUEL SYSTEM
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to match the fuel system components to the proper definitions and match the types of fuel filters and sediment bowls to the correct drawing of each. The student should be able to clean the sediment bowl and fuel filter, change the diesel fuel filter, bleed fuel lines on diesel engines, and remove water and sediment from diesel fuel. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After the completion of this unit, the student should be able to:

1. Explain in writing the purpose of the fuel system.
2. Match the fuel system components to the proper definitions.
3. Match the types of fuel filters and sediment bowls to the correct drawings of each.
4. Discuss in writing when to clean the sediment bowl and fuel filter.
5. Demonstrate the ability to:
    a. Clean sediment bowl and fuel filter.
    b. Change diesel fuel filter.
    c. Bleed fuel lines on diesel engine.
    d. Remove water and sediment from diesel fuel.

SERVICING TRACTOR FUEL SYSTEM
UNIT V

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information sheet.

   E. Demonstrate and discuss procedures outlined in the job sheets.

   F. Give test.

II. Unit references:

   A. American Association for Agricultural Engineering and Vocational Agriculture. *Tractor Maintenance.* Athens, Georgia: McCall Printing Co./Foote and Davis Division, 1970.

   B. American Association for Agricultural Engineering and Vocational Agriculture *Tractor Operation and Daily Care.* Athens, Georgia: McCall Printing/Foote and Davis Division, 1970.

SERVICING TRACTOR FUEL SYSTEM
UNIT V

INFORMATION SHEET

I. Purpose of the fuel system--To supply a combustible mixture of air and fuel to the engine cylinders

II. Components of the fuel system

A. Fuel tank--Reservoir to store fuel for engine use

B. Sediment bowl and filter--Allows water to settle out and catches particles of scale, rust, or foreign matter that will clog a carburetor

C. Fuel pump--Pumps fuel from the tank to the carburetor

(NOTE: The fuel pump on a diesel tractor acts as a primary pump delivering fuel from the fuel tank to the injector pump at low pressures.)

D. Carburetor--Device for automatically mixing fuel and air in the proper proportion for a combustible mixture

E. Fuel lines--Used to carry fuel from the fuel tank to the carburetor

F. Air cleaner--Used to filter grit and dust from the air entering the carburetor

G. Diesel injection pump--Applies high pressure to the fuel (1600 to 3200 psi) which is used by the injector nozzles to make a fine mist of the fuel as it is sprayed into the cylinder

(NOTE: Each cylinder has a separate injection nozzle.)

H. Fuel injector--Device which meters a fine mist of fuel into each cylinder at the appropriate time

(NOTE: Pressure of fuel at the injector nozzle may be 1600 psi to 3200 psi.)

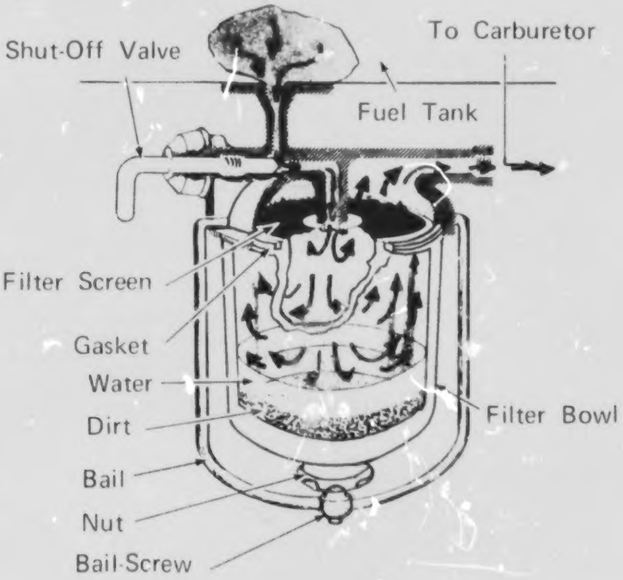
I. Primary filter--Removes most water and coarse material that may be in the fuel; also referred to as first-stage filter

J. Secondary filter--Removes any remaining material or water from the fuel; referred to as a second-stage, third-stage, or final filter

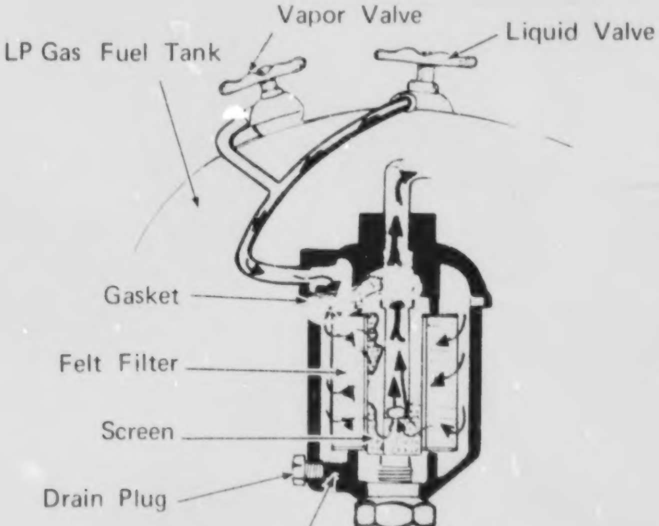
INFORMATION SHEET

III. Types of fuel filters and sediment bowls

A. Glass bowl with screen filter commonly used on gasoline and diesel tractors

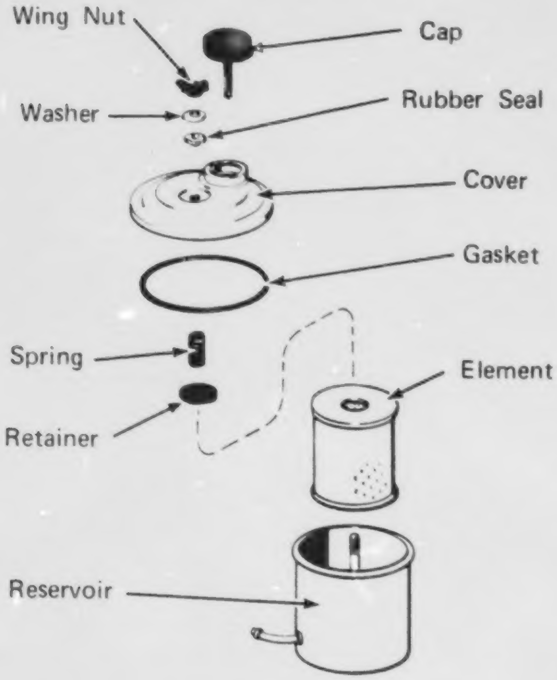

To Carburetor
Shut-Off Valve
Fuel Tank
Filter Screen
Gasket
Water
Filter Bowl
Dirt
Bail
Nut
Bail-Screw

B. Metal bowl with felt filter and screen often used on LP gas tractors

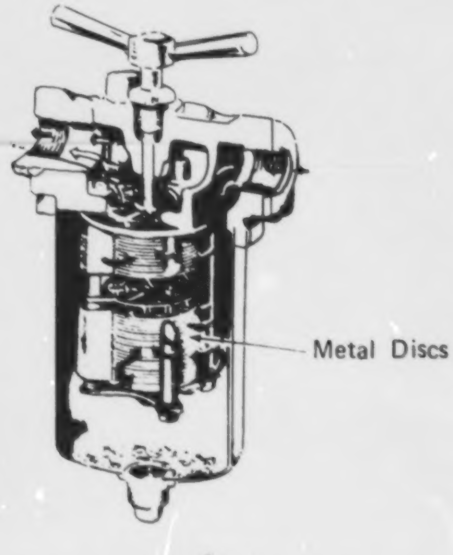

Vapor Valve
Liquid Valve
LP Gas Fuel Tank
Gasket
Felt Filter
Screen
Drain Plug
Sediment

INFORMATION SHEET

C. Diesel fuel filter used on diesel tractors


Wing Nut
Cap
Washer
Rubber Seal
Cover
Gasket
Spring
Element
Retainer
Reservoir

D. Edge-type (disc) filter sometimes used with either liquid or gas fuels


Metal Discs

INFORMATION SHEET

IV. When to clean sediment bowl and fuel filter

A. Recommendations for gasoline and diesel tractors vary from ten hours of operation to as long as 900 hours

(NOTE: Recommendations depend on make and type of tractor. Check the operator's manual for the time interval recommended for your tractor. Primary fuel filters should be checked daily for water.)

B. LP gas tractor's service interval varies from 100 hours to yearly

(NOTE: One company suggests that the LP gas filter be cleaned when it becomes clogged. Clogging is rather easily discovered with LP gas because the clogging action delays liquid movement so that a portion of it turns to gas in the sediment bowl, causing frost to form on the outside.)

SERVICING TRACTOR FUEL SYSTEM
UNIT V

JOB SHEET #1--CLEAN SEDIMENT BOWL AND FUEL FILTER

I. Tools and materials

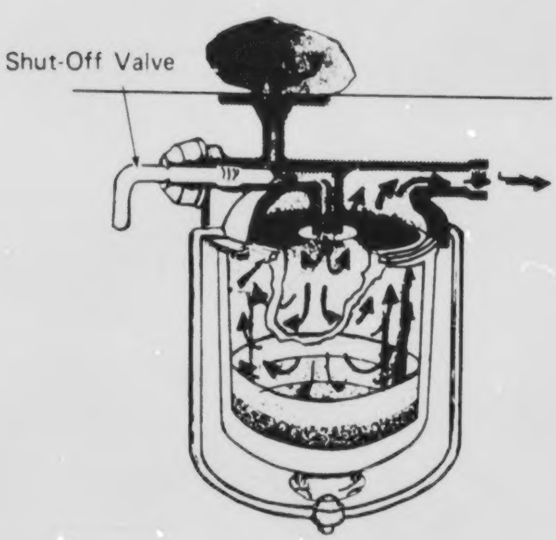
- A. Set of open end wrenches
- B. Container with cleaning solvent
- C. New gasket(s)
- D. Air under pressure

II. Procedure

- A. Close valve or valves on fuel supply line

  (NOTE: For liquid fuel tractors the shut-off valve is frequently a part of the filter assembly. See Figure 1. With LP gas be sure both the liquid and vapor valves are closed. See Figure 2.)

FIGURE 1



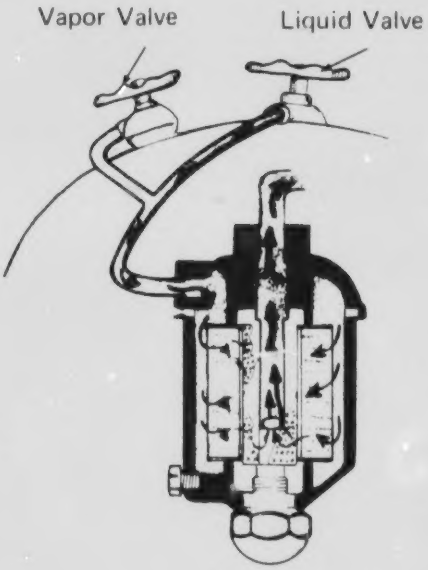


FIGURE 2

JOB SHEET #1

B. Loosen the nut that holds the sediment bowl in place

(NOTE: Sediment bowls on most liquid fuel tractors are held in place with a jam nut as in Figure 3. Sediment bowls for LP gas tractors may be held with a stud nut as in Figure 4 or may be threaded to the filter base as in Figure 5.)

FIGURE 3

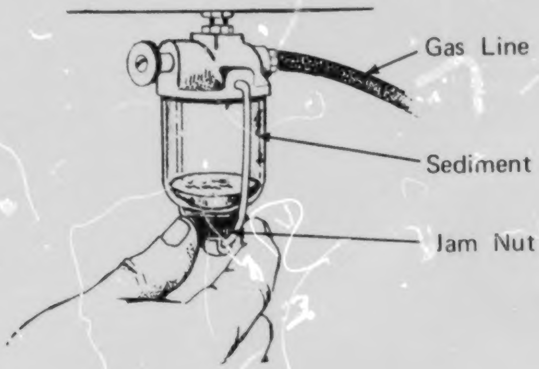

Gas Line
Sediment Bowl
Jam Nut

FIGURE 4

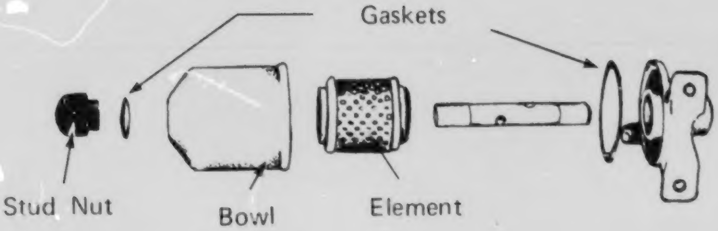
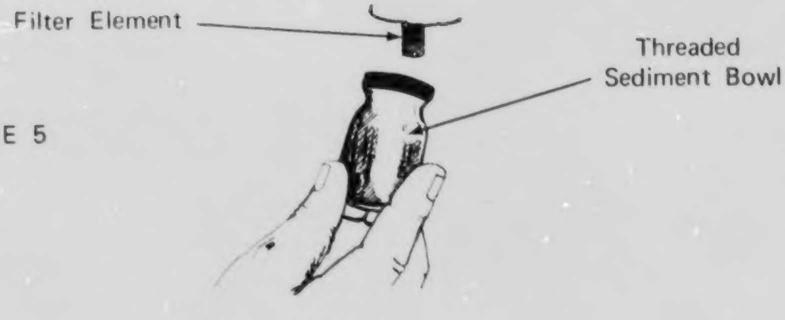

Gaskets
Stud Nut
Bowl
Element

FIGURE 5


Filter Element
Threaded
Sediment Bowl

JOB SHEET #1

C. Remove bowl with twisting motion

(NOTE: There is less danger of breaking the gasket if the glass bowl is twisted while being removed.)

D. Remove gasket

(NOTE: If the gasket is cracked or hard, be sure to replace with a new gasket. If you do not have a new gasket and the old one is still in good shape, note which side is next to the bowl, then turn it over so the opposite side will contact the bowl when you put it back in place.)

E. Remove strainer screen or filter

(NOTE: The screen is easily removed from the top of the sediment bowl since it is held in place by the clamping action between the bowl and gasket. If a filter is used in place of a screen, it will lift out easily or may be of the type to be unscrewed from the base of the assembly. See Figure 6. If the filter is of the edge type as shown in Figure 7, avoid rubbing the accumulated sediment into the filter unit. This tends to embed the material in the small openings and makes it difficult to remove.)

FIGURE 6

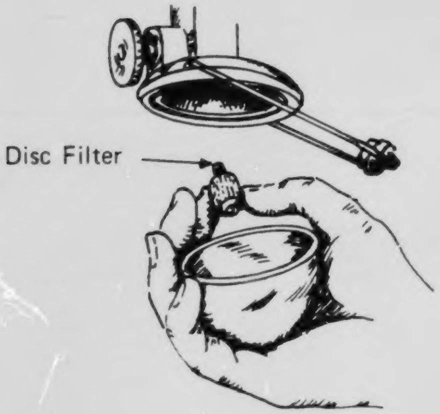
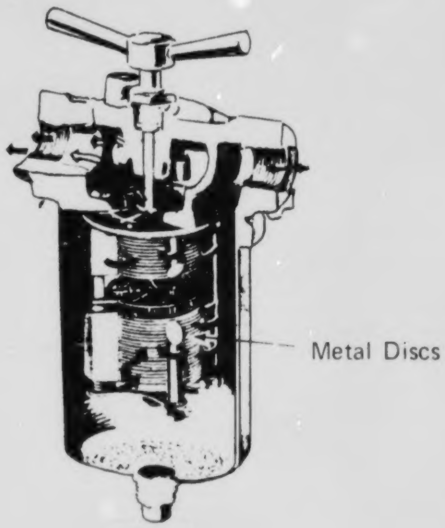


FIGURE 7



JOB SHEET #1

F. Wash screen or filter element

(NOTE: If the filter element is a disposable type as shown in Figure 8, it should be replaced with a new one. Wash the screen type in cleaning solvent. See Figure 9. Some disc type filters have screws on the end which will loosen the discs when unscrewed. If the screen or disc filter is difficult to clean, it may be because of gum and varnish residues that have collected. These may not be soluble in cleaning solvent. Use a paint remover, varnish solvent, acetone, or a mixture of one part alcohol and one part benzol. If a disc type filter is to be reinstalled in an LP gas tractor, finish drying the filter element by blowing air through one end. See Figure 10.)

FIGURE 8

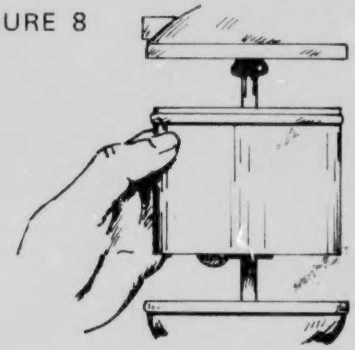


FIGURE 9

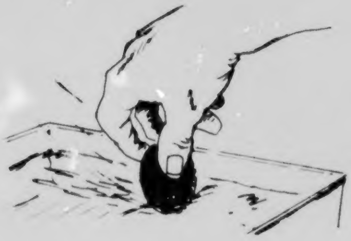
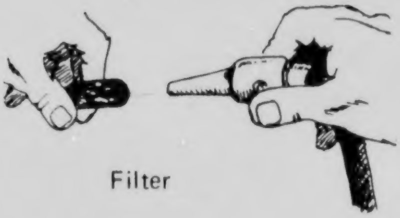


FIGURE 10



G. Clean sidement bowl

(NOTE: Use some of the cleaning solution on a cloth, then wipe dry enough so that no lint is left in the bowl.)

JOB SHEET #1

H. Open fuel valve and observe flow of fuel

(CAUTION: This does not apply to LP gas tractors.)

(NOTE: This tends to remove any dirt between the tank and the sediment bowl. It also serves as a check on the condition of the vent hole in the fuel-tank cap. If the vent hole is clogged, the flow will be slow as in Figure 11. Remove the tank cap and open the vent hole with cleaning solvent. See Figure 12. Be sure to catch fuel that is wasted from the fuel line. Careless handling causes a serious fire hazard.)

FIGURE 11

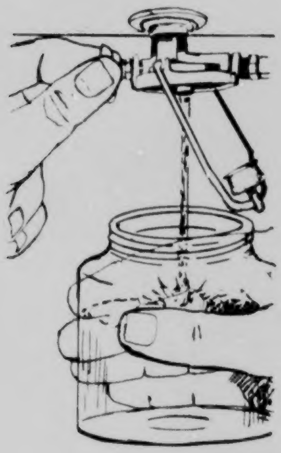
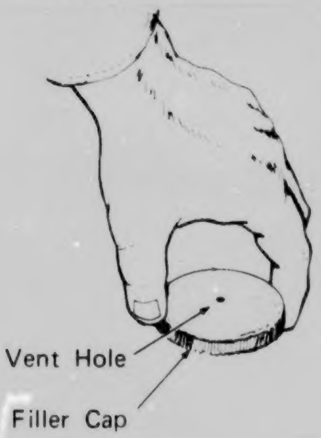


FIGURE 12



I. Reinstall gasket, strainer or filter, and sediment bowl

(NOTE: If it is a disc filter element, tighten it with your fingers. If tightened too much, the disc will warp and restrict the flow of fuel.)

J. Tighten bowl against gasket

(NOTE: Tighten completely for spark-ignition engines. For diesel engines, it may need to be installed loosely until air has been bled from the system; then tighten. Refer to Job Sheet #3 for bleeding diesel lines.)

K. Open the fuel valve, start the tractor, and check for leaks

SERVICING TRACTOR FUEL SYSTEM
UNIT V

JOB SHEET #2--CHANGE DIESEL FUEL FILTER

I. Tools and materials

A. Clean rags

B. Container with cleaning solvent

C. Container to catch wasted diesel fuel

D. Set of open end wrenches

E. Small scrub brush

F. Replaceable filters, if needed

II. Procedure

(NOTE: Always consult manufacturer's operator's manual.)

A. Turn off fuel supply at tank

B. Clean outside of filter body and engine area around filter; wipe dry

(NOTE: This is important to keep dirt from entering fuel system. Use a cloth and cleaning solvent to remove dirt, then wipe the cleaned area dry with a clean cloth.)

C. Drain fuel from filter

(NOTE: Most filters have a drain cock at the base or plug. Catch the fuel in a pan.)

D. Remove old filter

E. Clean inside of filter bowl, unless it is a self-contained type

(NOTE: If cloth is used, be sure it is lint free and clean. Some manufacturers recommend the use of a brush.)

F. Reinstall cleaned filter or new disposable filter element

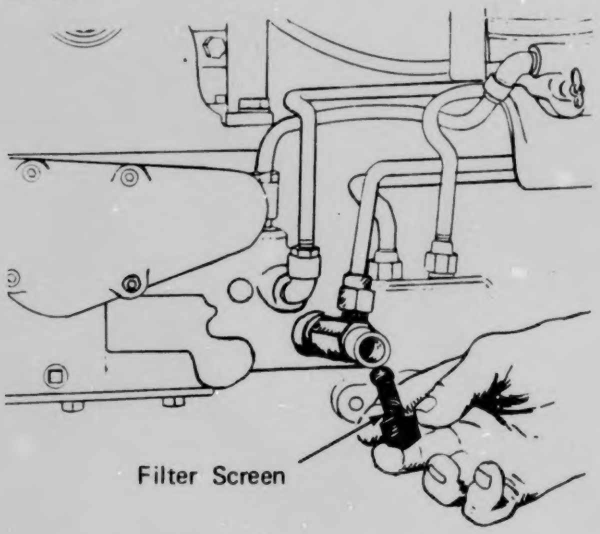
G. Complete the filter assembly and tighten it

JOB SHEET #2

H. Replace the drain plug or tighten the drain valve

(NOTE: Some tractors are equipped with a screen on the low pressure side near the primary pump. See Figure 1. If tractor is equipped with one of these, you may clean the screen when you service the filter element.)

FIGURE 1



SERVICING TRACTOR FUEL SYSTEM
UNIT V

JOB SHEET #3--BLEED FUEL LINES ON DIESEL ENGINE

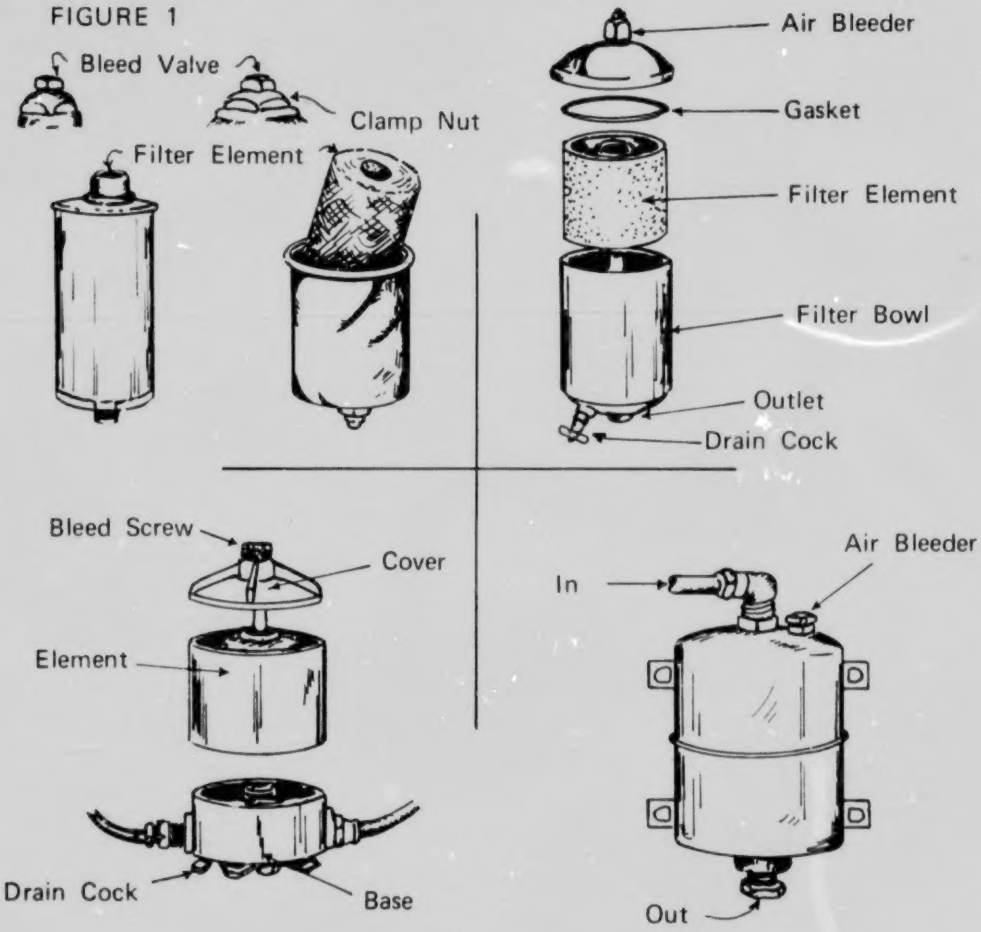
(NOTE: Each time the filters are drained and new filter elements installed, considerable air is left in the filter body and fuel line. If the air is left in the line, it may form an air lock when you try to start the engine. It is important to remove the air before you attempt to start the engine. Procedures are the same for the first, second, or third stage filters except as noted under each step. If more than one filter has been changed, bleed the one closest to the tank first.)

I. Materials--Set of open end wrenches

II. Procedure

A. Open bleed valve on top of filter (Figure 1)

FIGURE 1

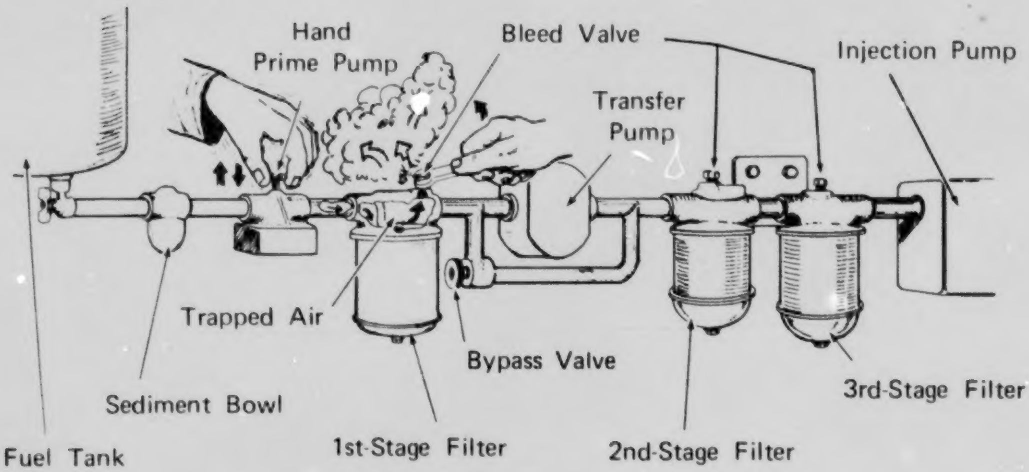

Bleed Valve
Clamp Nut
Filter Element
Air Bleeder
Gasket
Filter Element
Filter Bowl
Outlet
Drain Cock
Bleed Screw
Cover
Element
Drain Cock
Base
In
Air Bleeder
Out

JOB SHEET #3

B. Open fuel tank valve

(NOTE: This will force the air out through the bleed valve and replace the air space with fuel. Some tractors are equipped with a hand-prime pump to be used in removing air as shown in Figure 2. Several strokes of the hand pump quickly remove the air and replace it with fuel. If a transfer pump is located between the fuel tank and the filter you are bleeding, you will probably find a bypass line and valve. By opening the valve, fuel bypasses the pump so air can be bled out of the filter. See Figure 2.)

FIGURE 2


Hand Prime Pump
Bleed Valve
Injection Pump
Transfer Pump
Trapped Air
Bypass Valve
3rd-Stage Filter
Sediment Bowl
1st-Stage Filter
2nd-Stage Filter
Fuel Tank

C. Close bleed valve

(NOTE: Do this to avoid damaging seal. Do not overtighten.)

SERVICING TRACTOR FUEL SYSTEM
UNIT V

JOB SHEET #4--REMOVE WATER AND SEDIMENT FROM DIESEL FUEL

I. Tools and materials

- A. Clean rags
- B. Container to catch diesel fuel waste

II. Procedure

(NOTE: Use the directions in your operator's manual for the make and type of your tractor. If you haven't a manual, use the following procedures.)

- A. Check for drain cock
  - 1. Bottom of fuel tank (Figure 1)
  - 2. Bottom of first filter (Figures 2 and 3)
  - 3. Top of sediment bowl

FIGURE 1

Fuel Tank

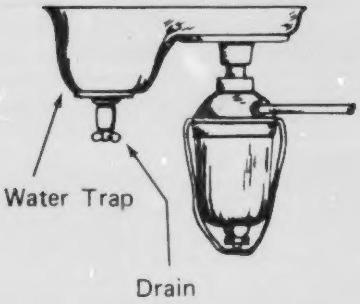


FIGURE 2

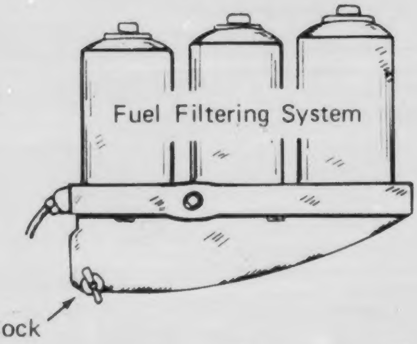
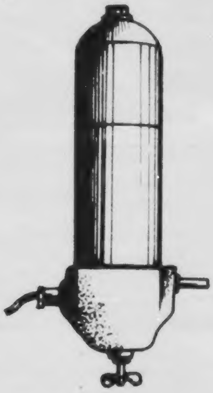


FIGURE 3



Filter On Top Of Another Filter With Drain Cock At Bottom

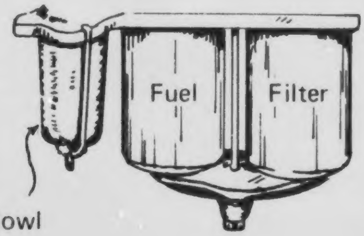
- B. If equipped with drain cock
  - 1. Open and drain about one pint of fuel

    (NOTE: This is done to make certain water and sediment are removed.)
  - 2. Close drain cock

JOB SHEET #4

C. If equipped with water trap and sediment bowl (Figure 4) and if sediment bowl is more than one-third full of water

FIGURE 4



Water Trap and Sediment Bowl

1. Close fuel valve under fuel tank
2. Loosen thumb nut under bowl and swing bail to one side
3. Remove glass bowl, empty, and clean

   (NOTE: Be careful not to lose the gasket the filter bowl presses against. When bowl is removed, the gasket may be on top of bowl or may remain in top of filter assembly.)

4. Wash glass bowl in cleaning solvent to remove dirt and sediment
5. Install bowl loosely

   (NOTE: When installing bowl, be sure to check the gasket. If it is not in good shape, replace the gasket with a new one.)

6. Open fuel valve and allow bowl to fill

   (NOTE: With bowl mounted loosely, the fuel forces air out of top of bowl.)

7. Tighten thumb nut under bowl when air is completely removed

SERVICING TRACTOR FUEL SYSTEM
UNIT V

TEST

NAME________________________________SCORE________________

1. Explain in writing the purpose of the fuel system.

____

____

____

2. Match the fuel system components on the right to the proper definitions by placing the appropriate numbers in the blanks provided.

_____a. Used to filter grit and dust from the air entering the carburetor

_____b. Device for automatically mixing fuel and air in the proper proportion for a combustible mixture

_____c. Used to carry fuel from the fuel tank to the carburetor

_____d. Reservoir to store fuel for engine use

_____e. Allows water to settle out and catches particles of scale, rust, or foreign matter that will clog a carburetor

_____f. Pumps fuel from the tank to the carburetor

_____g. Applies high pressure to the fuel (1600-3200 psi) which is used by the injector nozzles to make a fine mist of the fuel as it is sprayed into the cylinder

_____h. Removes most water and coarse material that may be in the fuel; also referred to as first-stage filter

_____i. Device which meters a fine mist of fuel into each cylinder at the appropriate time

_____j. Removes any remaining material or water from the fuel; referred to as a second-stage, third-stage, or final filter

1. Fuel tank
2. Sediment bowl and filter
3. Fuel pump
4. Carburetor
5. Fuel lines
6. Diesel injection pump
7. Air cleaner
8. Primary filter
9. Secondary filter
10. Fuel injector

3. Match the fuel filters and sediment bowls listed below to the following drawings.

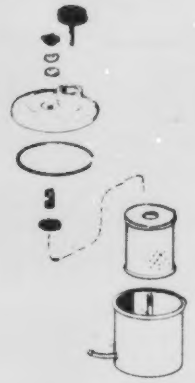
_____a. Glass bowl with screen filter commonly used on gasoline and diesel tractors

_____b. Metal bowl with felt filter and screen often used on LP gas tractors

_____c. Diesel fuel filter used on diesel tractors

_____d. Edge-type (disc) filter sometimes used with either liquid or gas fuels

1.



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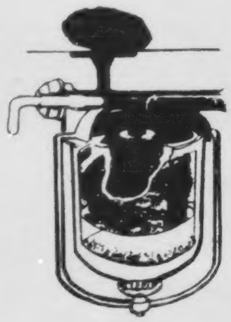

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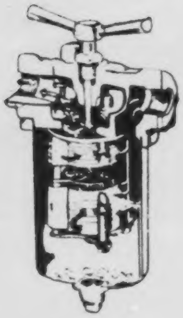

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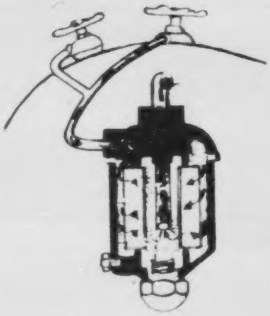


4. Discuss in writing when to clean the sediment bowl and fuel filter.

____

____

____

____

5. Demonstrate the ability to:

a. Clean sediment bowl and fuel filter.

b. Change diesel fuel filter.

c. Bleed fuel lines on diesel engine.

d. Remove water and sediment from diesel fuel.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR FUEL SYSTEM
UNIT V

ANSWERS TO TEST

1. Explain in writing the purpose of the fuel system.

   To supply a combustible mixture of air and fuel to the engine cylinders

2. Match the fuel system components on the right to the proper definitions by placing the appropriate numbers in the blanks provided.

   7 a. Used to filter grit and dust from the air entering the carburetor

   4 b. Device for automatically mixing fuel and air in the proper proportion for a combustible mixture

   5 c. Used to carry fuel from the fuel tank to the carburetor

   1 d. Reservoir to store fuel for engine use

   2 e. Allows water to settle out and catches particles of scale, rust, or foreign matter that will clog a carburetor

   3 f. Pumps fuel from the tank to the carburetor

   6 g. Applies high pressure to the fuel (1600-3200 psi) which is used by the injector nozzles to make a fine mist of the fuel as it is sprayed into the cylinder

   8 h. Removes most water and coarse material that may be in the fuel; also referred to as first-stage filter

   10 i. Device which meters a fine mist of fuel into each cylinder at the appropriate time

   9 j. Removes any remaining material or water from the fuel; referred to as a second-stage, third-stage, or final filter

   1. Fuel tank
   2. Sediment bowl and filter
   3. Fuel pump
   4. Carburetor
   5. Fuel lines
   6. Diesel injection pump
   7. Air cleaner
   8. Primary filter
   9. Secondary filter
   10. Fuel injector

3. Match the fuel filters and sediment bowls listed below to the following drawings.

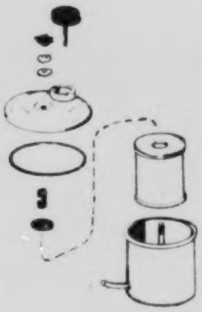
   2 a. Glass bowl with screen filter commonly used on gasoline and diesel tractors

   4 b. Metal bowl with felt filter and screen often used on LP gas tractors

   1 c. Diesel fuel filter used on diesel tractors

   3 d. Edge-type (disc) filter sometimes used with either liquid or gas fuels

1.



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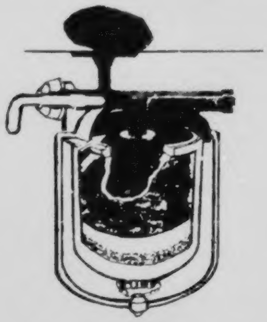

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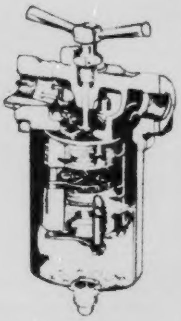

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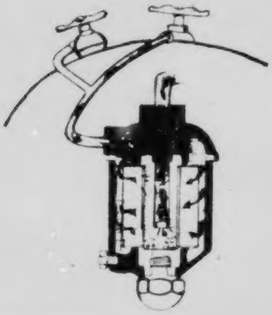


4. Discuss in writing when to clean the sediment bowl and fuel filter.

   a. Recommendations for gasoline and diesel tractors vary from ten hours of operation to as long as 900 hours

   b. LP gas tractor's service interval varies from 100 hours to yearly

5. Demonstrate the ability to:

   a. Clean sediment bowl and fuel filter.

   b. Change diesel fuel filter.

   c. Bleed fuel lines on diesel engine.

   d. Remove water and sediment from diesel fuel.

   (NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR AIR SYSTEM
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between the two common types of air cleaners, discuss in writing the importance of proper air cleaner maintenance, and list the methods of cleaning the filter element. The student should be able to demonstrate the ability to remove and clean the dry-type air cleaner and service the oil-bath air cleaner. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Distinguish between the two common types of air cleaners when given the characteristics of each.
2. Name the advantages of a dry-type air cleaner over an oil-bath cleaner.
3. Discuss in writing the importance of proper air cleaner maintenance.
4. Select from a list the differences between dry-type air cleaners found in tractors and those found in automobiles.
5. List the methods of cleaning the filter element.
6. Demonstrate the ability to:
   a. Remove the dry-type air cleaner.
   b. Clean the dry-type air cleaner.
   c. Service the oil-bath air cleaner.

SERVICING TRACTOR AIR SYSTEM
UNIT VI

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Unit references:

   A. American Association for Agricultural Engineering and Vocational Agriculture. *Tractor Maintenance.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

   B. American Association for Agricultural Engineering and Vocational Agriculture. *Tractor Operation and Daily Care.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

SERVICING TRACTOR AIR SYSTEM
UNIT VI

INFORMATION SHEET

I. Two common types of air cleaners

   A. Oil-bath type (Transparency 1)

      1. Depends on washing the air free of dust particles by pulling it through a bath of oil

      2. Should be serviced daily

      3. Is highly efficient when operating under the conditions for which it is designed

         (NOTE: It is not always operating under designed conditions, so the efficiency may be lower at times when the air flow drops below its rated capacity.)

   B. Dry (paper-filter) type (Transparency 2)

      1. Depends on a special paper to filter out dirt particles

      2. Normally needs servicing every 50 hours

      3. Is built for two-stage cleaning

         a. Precleaning

         b. Filtering

II. Advantages of a dry-type air cleaner over an oil-bath cleaner

   A. Easier to service

   B. Requires less frequent servicing

   C. Fuzz and chaff cause less restriction to air passage

   D. Less messy

   E. More efficient at a wide range of conditions

   F. Neglecting air cleaner servicing does not harm the engine as long as there is no hole in the filter or loose fitting where dirt can get through

INFORMATION SHEET

III. Importance of proper air cleaner maintenance

  A. Dirt, which enters the intake manifold of an engine and passes into the engine cylinders, mixes with the oil on the cylinder walls to form a grinding compound

  B. Tractors operating under dusty conditions without an air filter have been known to wear so rapidly that they require major overhaul after operating fifteen hours or less

  (NOTE: Manufacturers have made every effort to equip tractors with the most efficient air cleaner available so the owner will get the longest possible usage before an overhaul is necessary.)

IV. Differences between dry-type cleaner found in tractors and those in automobiles

  A. Tractor cleaner is equipped with a precleaner for removing large particles of dirt

  B. Tractor cleaner has a filter element that is larger for the same horsepower engine

  C. Tractor cleaner has a filter element that is built much more ruggedly to withstand vibration and high engine suction when clogged with dirt

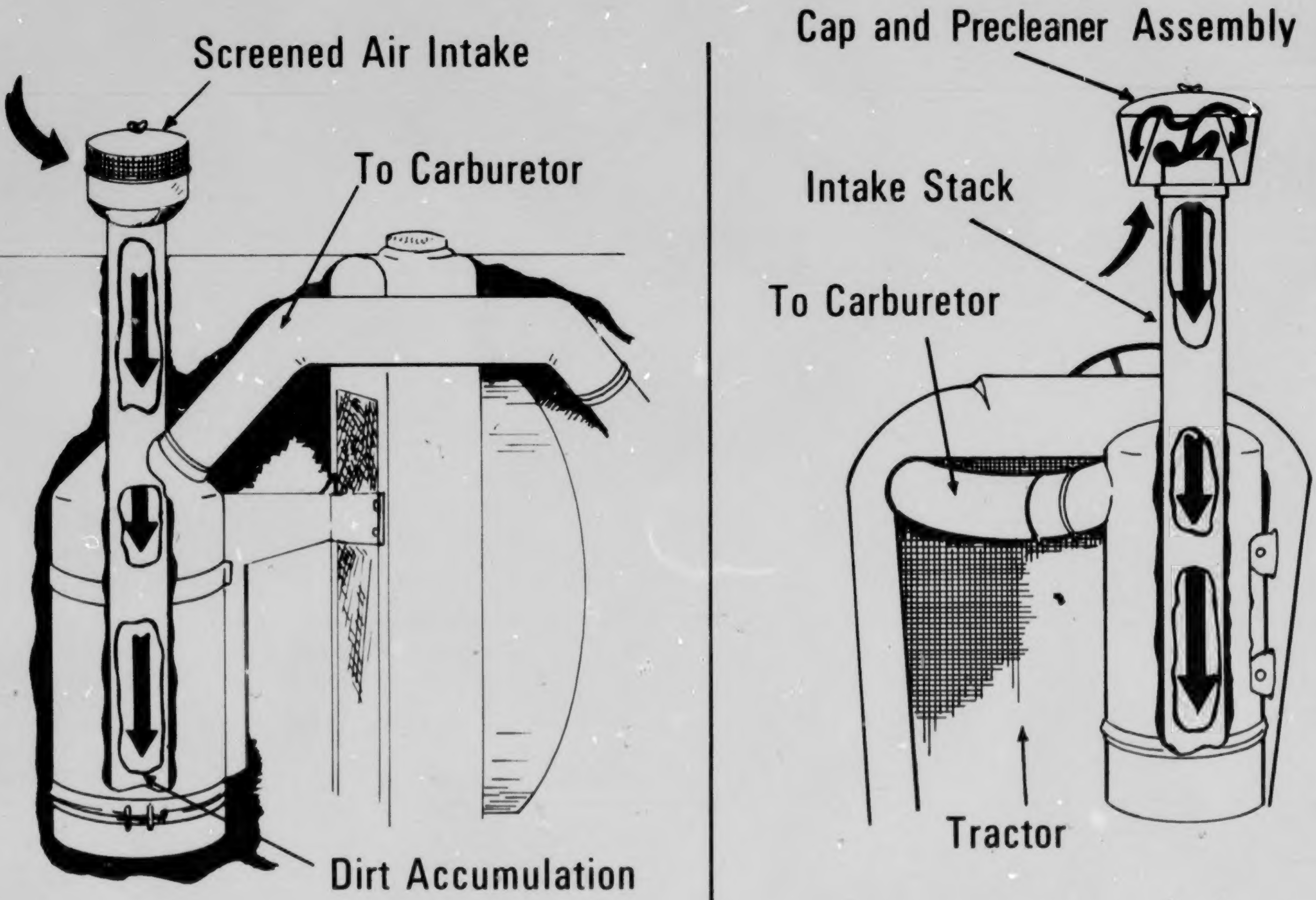
V. Methods of cleaning the filter element

  A. Tapping against palm of hand to loosen dust so it can be shaken out

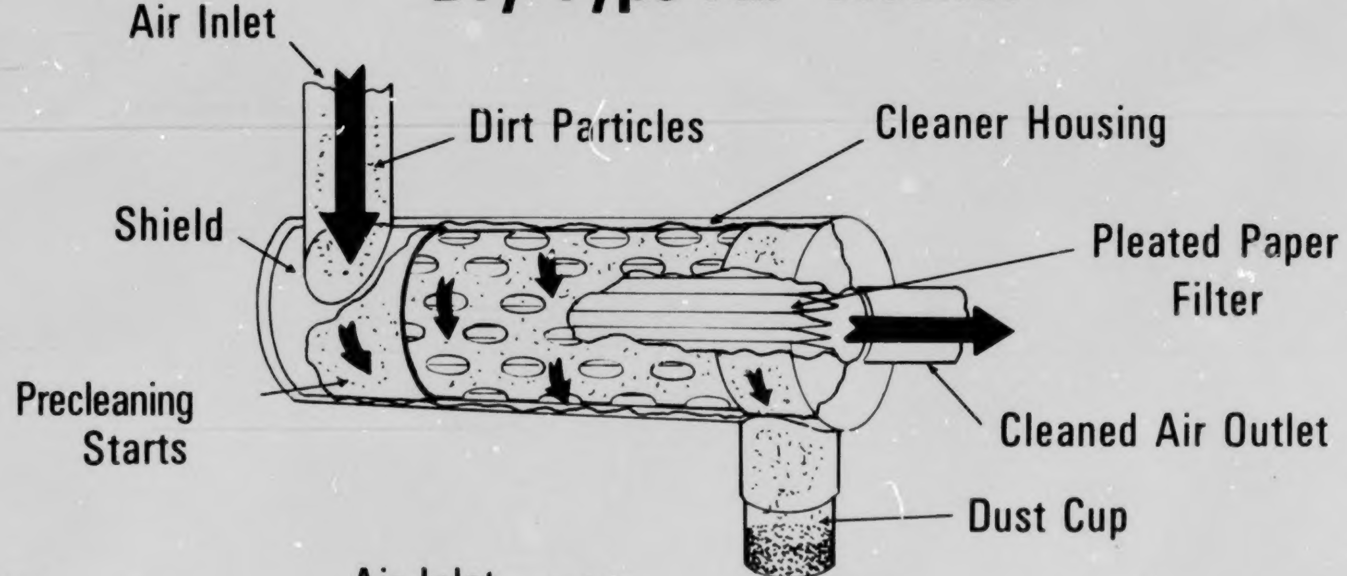
  B. Use of compressed air

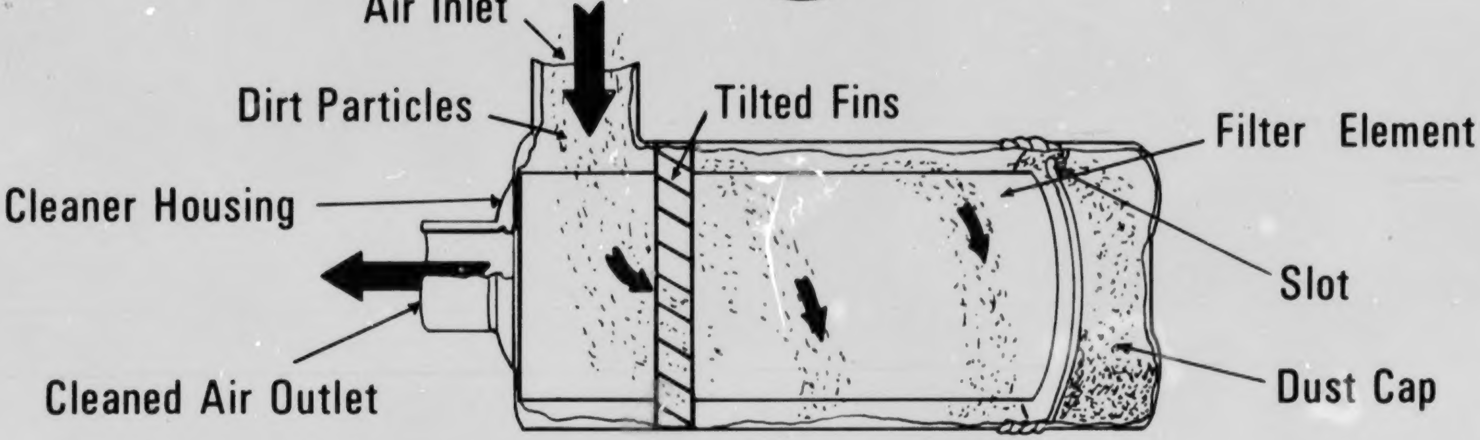
  C. Washing with water and a detergent

Oil-Bath Air Cleaner


Screened Air Intake
To Carburetor
Dirt Accumulation
Cap and Precleaner Assembly
Intake Stack
To Carburetor
Tractor

Dry-Type Air Cleaner


Air Inlet
Dirt Particles
Cleaner Housing
Shield
Pleated Paper Filter
Precleaning Starts
Cleaned Air Outlet
Dust Cup


Air Inlet
Dirt Particles
Tilted Fins
Filter Element
Cleaner Housing
Slot
Dust Cap
Cleaned Air Outlet

SERVICING TRACTOR AIR SYSTEM
UNIT VI

JOB SHEET #1--REMOVE THE DRY-TYPE AIR CLEANER

I. Tools and materials

A. Compressed air not to exceed 80 pounds per square inch of pressure

B. Bucket of warm water with a nonsudsing detergent

(NOTE: Follow specifications of manufacturer.)

C. Water under pressure at not more than 40 pounds per square inch

II. Procedure

A. Stop engine if it is running

B. Squeeze dust unloader if supplied on the air cleaner

(NOTE: Some tractors are equipped with a connection to the engine exhaust system which will automatically unload the dirt from the precleaner.)

C. Remove hood or grill, if necessary, to provide access to air cleaner unit

D. Wipe off dust accumulated around end of cleaner where element will be removed

E. Loosen hand screw or clamp that holds the end cap on the end of the cleaner; remove cap

F. Clean the area around the element and clean the dust cap and baffle on air cleaners having end cups

(NOTE: Use a dry cloth. Do not use gasoline, fuel oil, or solvent.)

G. Check condition of rubber gasket on end of filter element

(NOTE: If the gasket is damaged or missing, replace the filter element with a new one. Do not bother to clean it. If reinstalled, uncleaned air will pass directly from the precleaner into the engine and cause rapid wear.)

SERVICING TRACTOR AIR SYSTEM
UNIT VI

JOB SHEET #2--CLEAN THE DRY-TYPE AIR CLEANER

I. Tools and materials

A. Compressed air not to exceed 80 pounds per square inch of pressure

B. Bucket of warm water with a nonsudsing detergent

(NOTE: Follow specifications of manufacturer.)

C. Water under pressure at not more than 40 pounds per square inch

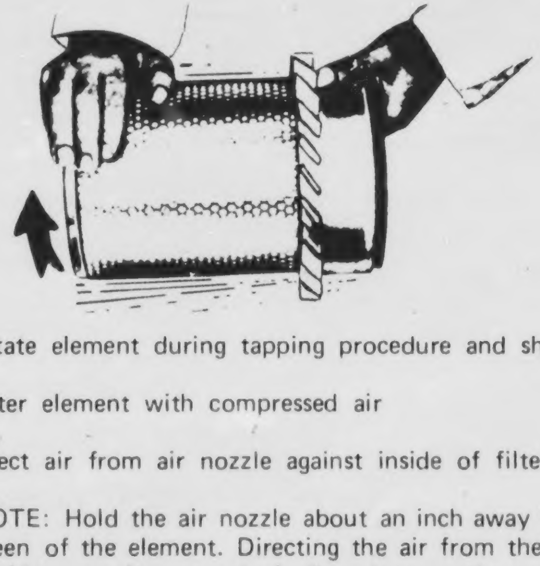
II. Procedure

A. Clean the filter element by tapping

1. Tap filter element to loosen dirt, but gently enough that element is not damaged (Figure 1)

(NOTE: You may tap the element carefully against the palm of your hand.)

FIGURE 1



2. Rotate element during tapping procedure and shake out dust

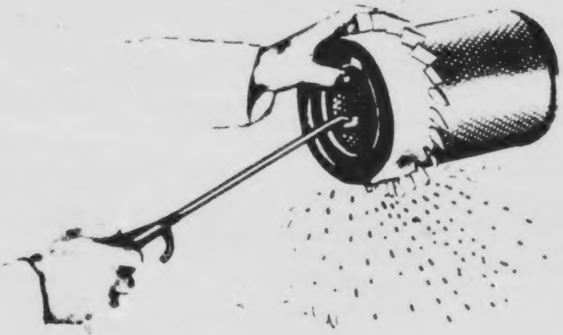
B. Clean the filter element with compressed air

1. Direct air from air nozzle against inside of filter element

(NOTE: Hold the air nozzle about an inch away from the inner screen of the element. Directing the air from the center to the outside opposite normal air flow loosens the outside dirt and opens the small passageways in the paper filter. Blowing air from the outside to the center tends to compact the dirt in the small openings in the paper filter. It is helpful if the air nozzle is equipped with a deflector to spread the air to avoid blowing a hole in the filter element. The air must be dry and pressure at the nozzle not to exceed 80 pounds per square inch. See Figure 2.)

JOB SHEET #2

FIGURE 2



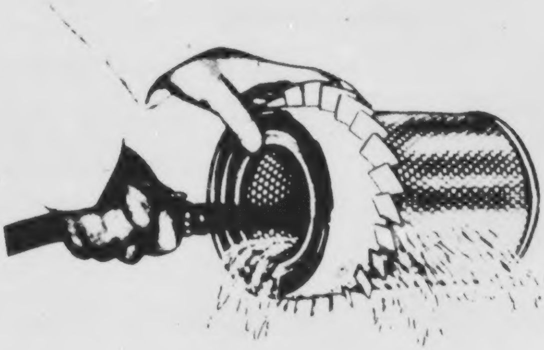
2. Continue blowing and rotating the element until it is clean

C. Clean the filter element by washing

(NOTE: Some manufacturers do not recommend the use of water.)

1. Clean away as much dirt as possible with clean water from a hose or use compressed air (Figure 3)

FIGURE 3

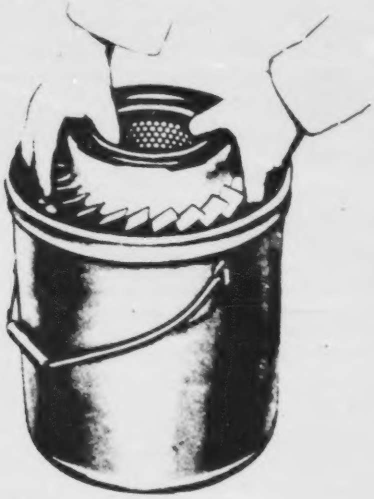


JOB SHEET #2

2. Wash element in warm water and detergent (Figure 4)

   (NOTE: Use a nonsudsing detergent. Do not use fuel oil, gasoline, or other petroleum solvents.)

FIGURE 4



3. Rinse the element

   (NOTE: Use clean water as shown, then shake excess water from element.)

4. Allow element to dry

   (NOTE: Allow approximately 24 hours at 70° F for the drying time. Be sure you do not leave the wet element where it will be exposed to freezing weather.

   Do not use compressed air or engine air flow to dry the filter element. It will probably rupture the paper filter. Do not oven dry.)

5. Inspect element for damage

   (NOTE: If there is a slight rupture in the paper element, throw it away.)

D. Install the filter element

   1. Replace the filter element in the cleaner; be certain engine is not running when the element is replaced
   2. Tighten wing nut (with fingers only) that holds element in place
   3. Complete remaining procedures in reverse order from those used to remove the filter element

SERVICING TRACTOR AIR SYSTEM
UNIT VI

JOB SHEET #3--SERVICE THE OIL-BATH AIR CLEANER

I. Tools and materials

A. Cleaning rags

B. Large container of cleaning solvent

(CAUTION: Cleaning solvent should have a high flash point. Also, some cleaning solvents may be harmful to hands. Wear rubber gloves.)

C. Set of open end wrenches

D. Screwdriver

E. Pliers

F. Stick about three feet long

G. Cup or pitcher

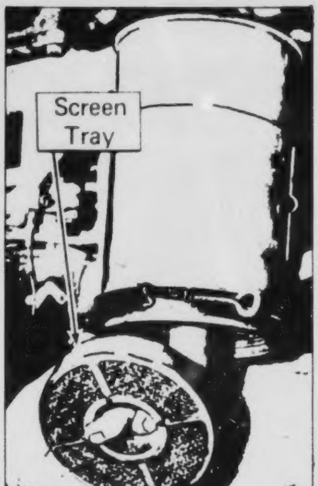
H. Oil, proper weight recommended by manufacturer

II. Procedure

A. Remove oil cup and screen tray (Figure 1)

(NOTE: Some air cleaners have no screen tray.)

FIGURE 1

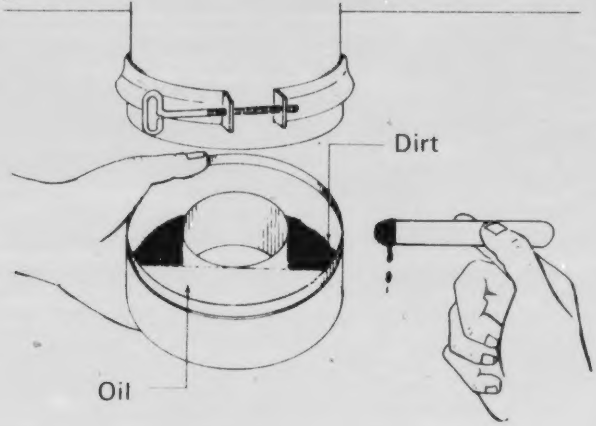


JOB SHEET #3

B. Check depth of sediment deposit in outer chamber (Figure 2)

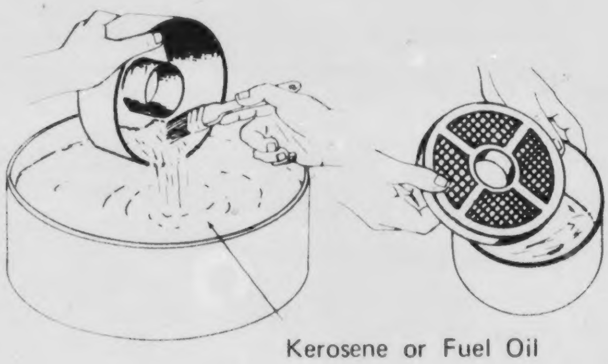
(NOTE: If sediment in the outer compartment is more than 1/2 inch in depth, proceed with cleaning the cup. If the oil has thickened even though the dirt depth may not be 1/2 inch, change the oil.)

FIGURE 2



C. Throw away dirty oil, scrape, and then wash inner and outer cups with clean kerosene, mineral spirits, or diesel fuel if cup needs cleaning (Figure 3)

FIGURE 3

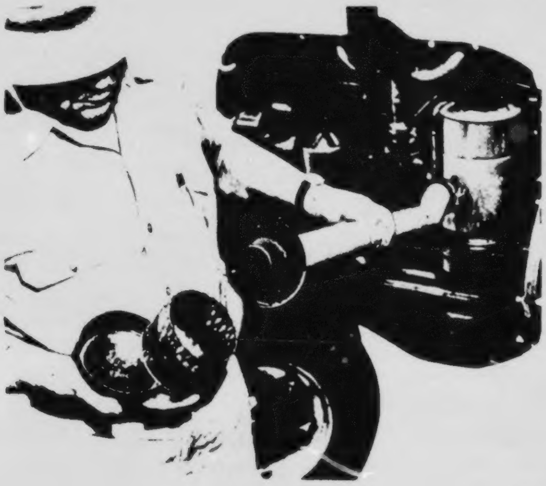


JOB SHEET #3

D. Inspect center tube and lower filter element

(NOTE: If both the center tube and lower filter appear dirty, remove the complete filter body for adequate cleaning. If tractor has a vertical stack with a precleaner on top, remove that assembly first. See Figure 4.)

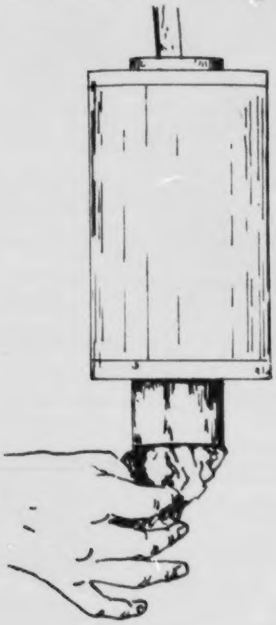
FIGURE 4



E. Remove dirt from center tube (Figure 5)

(NOTE: Use a lintless cloth soaked with diesel fuel or kerosene and push it through the center tube with a stick. Some center tubes are smaller at the lower end so be careful not to damage the tube.)

FIGURE 5

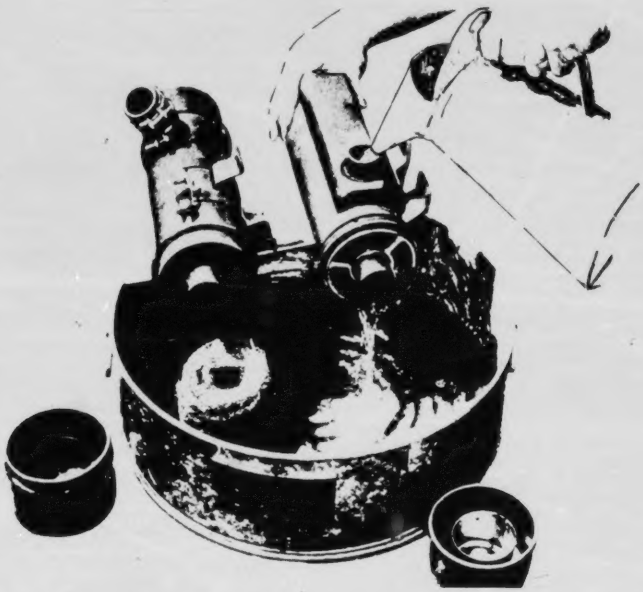


JOB SHEET #3

F. Clean dirt from lower filter

(NOTE: On many filters there is an upper and lower filter separation screen that makes up the filter element. On most elements the lower filter can be removed. If the filtering element is held in place by spot welding or other means, flush the cleaning solvent through the mesh as shown in Figure 6.)

FIGURE 6



G. Clean shell and upper metal-wool filter

(NOTE: Soak the entire assembly in kerosene or fuel oil; then flush with cleaning solvent to remove the loosened oil and dust.)

H. Drain filter body and screen for several minutes

(NOTE: Do not use gasoline for cleaning.)

I. Clean the screened air intake cup with precleaner

J. Check hose connections

K. Refill cup with oil to Oil Level mark

(NOTE: Most operator's manuals recommend the same weight oil as used in the engine crankcase. Do not use oil lighter than 20w or diesel oil in the air cleaner.)

JOB SHEET #3

L. Reassemble filter parts

(NOTE: Be sure all connections are tight and any worn or damaged hoses or gaskets replaced. If there is any place where uncleaned air can enter the air ducts, particularly after the air has passed through the cleaner, dirt and grit will enter and greatly increase tractor wear.)

SERVICING TRACTOR AIR SYSTEM
UNIT VI

TEST

NAME______________________________________SCORE____________________

1. Distinguish between the two common types of air cleaners. Place an "O" by the characteristics that apply to an oil-bath air cleaner and "D" by the characteristics that apply to a dry-type air cleaner.

_____a. Normally needs servicing every 50 hours

_____b. Depends on washing the air free of dust particles by pulling it through a bath of oil

_____c. Depends on a special paper to filter out dirt particles

_____d. Should be serviced daily

2. Name three advantages of a dry-type air cleaner over an oil-bath cleaner.

a. ____

b. ____

c. ____

3. Discuss in writing the importance of proper air cleaner maintenance.

____

____

____

____

____

____

4. Select from the list below the differences between dry-type air cleaners found in tractors and those found in automobiles. Place an "X" by the statements that are correct.

_____a. Tractor cleaner is equipped with a precleaner for removing large particles of dirt

_____b. Automobile cleaner has a filter element that is larger for the same horsepower engine

_____c. Tractor cleaner has a filter element that is built much more ruggedly to withstand vibration and high engine suction when clogged with dirt

5. List the methods of cleaning the filter element.

   a. ______________________________

   b. ______________________________

   c. ______________________________

6. Demonstrate the ability to:

   a. Remove the dry-type air cleaner.

   b. Clean the dry-type air cleaner.

   c. Service the oil-bath air cleaner.

   (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR AIR SYSTEM
UNIT VI

ANSWERS TO TEST

1. Distinguish between the two common types of air cleaners. Place an "O" by the characteristics that apply to an oil-bath air cleaner and "D" by the characteristics that apply to a dry-type air cleaner.

   __D__ a. Normally needs servicing every 50 hours

   __O__ b. Depends on washing the air free of dust particles by pulling it through a bath of oil

   __D__ c. Depends on a special paper to filter out dirt particles

   __O__ d. Should be serviced daily

2. Name three advantages of a dry-type air cleaner over an oil-bath cleaner.

   (NOTE: Any three of the following are acceptable.)

   a. Easier to service

   b. Requires less frequent servicing

   c. Fuzz and chaff cause less restriction to air passage

   d. Less messy

   e. More efficient at a wide range of conditions

   f. Neglecting air cleaner servicing does not harm the engine as long as there is no hole in the filter or a loose fitting where dirt can get through

3. Discuss in writing the importance of proper air cleaner maintenance.

   a. Dirt, which enters the intake manifold of an engine and passes into the engine cylinders, mixes with the oil on the cylinder walls to form a grinding compound

   b. Tractors operating under dusty conditions without an air filter have been known to wear so rapidly that they require major overhaul after operating fifteen hours or less

4. Select from the list below the differences between dry-type air cleaners found in tractors and those found in automobiles. Place an "X" by the statements that are correct.

   __X__ a. Tractor cleaner is equipped with a precleaner for removing large particles of dirt

   _____ b. Automobile cleaner has a filter element that is larger for the same horsepower engine

   __X__ c. Tractor cleaner has a filter element that is built much more ruggedly to withstand vibration and high engine suction when clogged with dirt

5. List the methods of cleaning the filter element.

   a. Tapping against palm of hand to loosen dust so it can be shaken out

   b. Use of compressed air

   c. Washing with water and a detergent

6. Demonstrate the ability to:

   a. Remove the dry-type air cleaner.

   b. Clean the dry-type air cleaner.

   c. Service the oil-bath air cleaner.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to name the common causes of wheel bearing failures and identify the components of a wheel assembly. The student should be able to disassemble, clean, pack, and assemble wheel bearings. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Explain in writing the importance of wheel bearing service.
2. Select from a list the proper service interval for wheel bearings.
3. Name the common causes of wheel bearing failures.
4. Identify the components of a wheel assembly.
5. Demonstrate the ability to:
    a. Disassemble the wheel bearings.
    b. Clean the wheel bearings.
    c. Pack and assemble the wheel bearings.

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and job sheets.

   C. Make transparency.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   G. Give test.

II. Unit references:

   A. American Association for Vocational Instructional Materials. *Tractor Maintenance.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

   B. National 4-H Tractor Program Development Committee. *4-H Tractor Program: Third Year.* Chicago: National 4-H Service Committee, 1963.

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

INFORMATION SHEET

I. Importance of wheel bearing service--Due to work in dusty areas, tractor wheel bearings are often subjected to needless wear if not kept properly adjusted and lubricated

(NOTE: If grit and dirt particles are allowed to enter the bearings, damage begins to show on the raceway. If this continues, the bearing will soon be ruined and have to be replaced.)

II. Proper service interval for wheel bearings

A. Interval varies from 500 to 1,200 hours

B. Tractor operator's manual should be checked for recommendations on a given tractor

(NOTE: The wheel bearing service interval has been gradually lengthened as manufacturers have found better methods of protecting the bearings from dirt and water. The fact that wheel bearings are serviced infrequently makes it all the more important to do it regularly and properly.)

C. If tractor has a grease fitting for gun lubrication, grease daily or twice per day

D. Wheel bearings should be serviced at least once per year

III. Common causes of wheel bearing failures

A. Faulty dust seal

B. Improper lubrication

C. Loose bearings

D. Operating wheels underwater

E. Operating the tractor with a heavy load on the wheel bearings

F. Operating with bearings too tight

IV. Components of a wheel assembly (Transparency 1)

A. Spindle

B. Grease seal

INFORMATION SHEET

C. Grease seal cup

D. Inner bearing cone and roller

E. Inner bearing cup

F. Hub

G. Outer bearing cup

H. Outer bearing cone and roller

I. Wheel

J. Washer

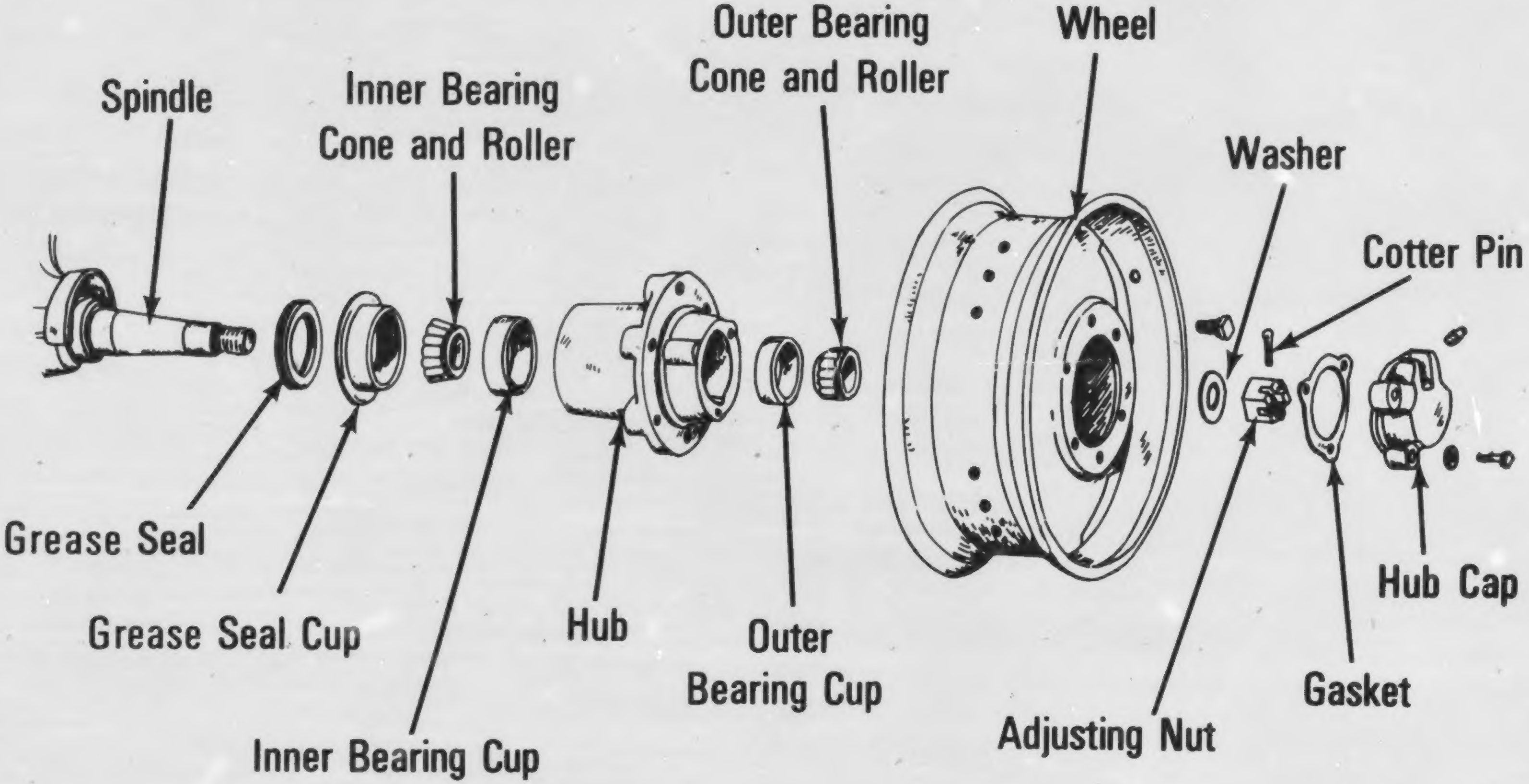
K. Adjusting nut

L. Cotter pin

M. Gasket

N. Hub cap

Components of a Wheel Assembly


Spindle
Inner Bearing Cone and Roller
Outer Bearing Cone and Roller
Wheel
Washer
Cotter Pin
Grease Seal
Grease Seal Cup
Inner Bearing Cup
Hub
Outer Bearing Cup
Adjusting Nut
Gasket
Hub Cap

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

JOB SHEET #1--DISASSEMBLE THE WHEEL BEARINGS

I. Tools and materials

A. Set of open end wrenches

B. Diagonal pliers

C. Clean rags

D. Wood block, about 6 inches high (for dual-wheel, tricycle tractors) or small hydraulic jack

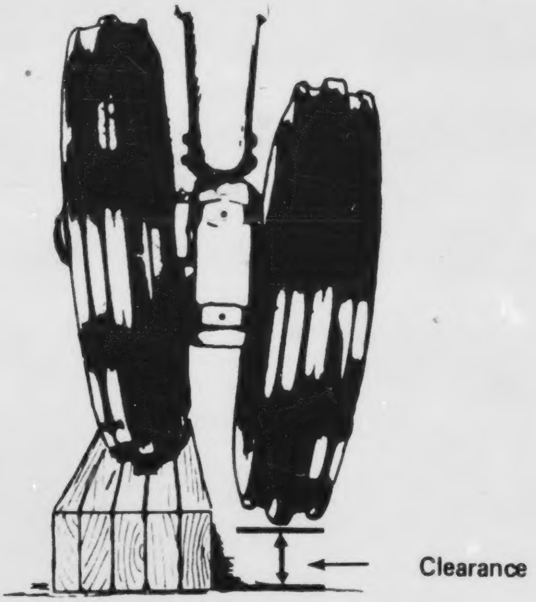
II. Procedure

(NOTE: Follow all of the manufacturer's recommendations.)

A. Raise wheel off the ground

(NOTE: With many dual-wheel tricycle tractors, you can provide clearance for one wheel by running the other up on a six-inch block as shown in Figure 1. If your tractor has a wide front axle, jack up one wheel at a time. Be sure your tractor is in gear or block the rear wheels so it will not move forward or backward. Use caution to keep tractor from falling off jack. A stand or safety jack should be used.)

FIGURE 1



JOB SHEET #1

B. Clean dirt from wheel and hub cap and remove hub cap

(NOTE: Most hub caps are either threaded and screwed on the hub as in Figure 2a or are held in place with three stud bolts as in Figure 2b. The latter has a gasket under it. Remove the cap carefully so as not to damage the gasket.)

FIGURE 2a

Threaded and Screwed On

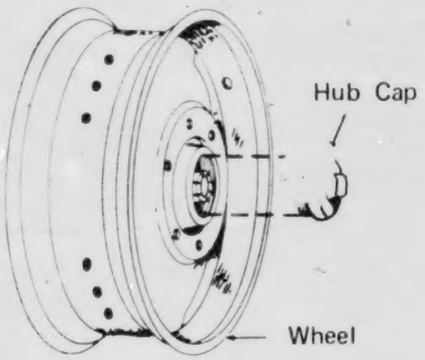
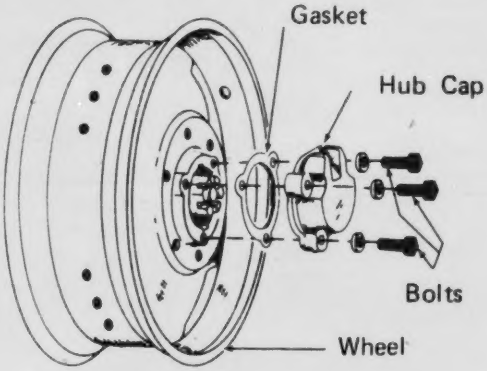

Hub Cap
Wheel

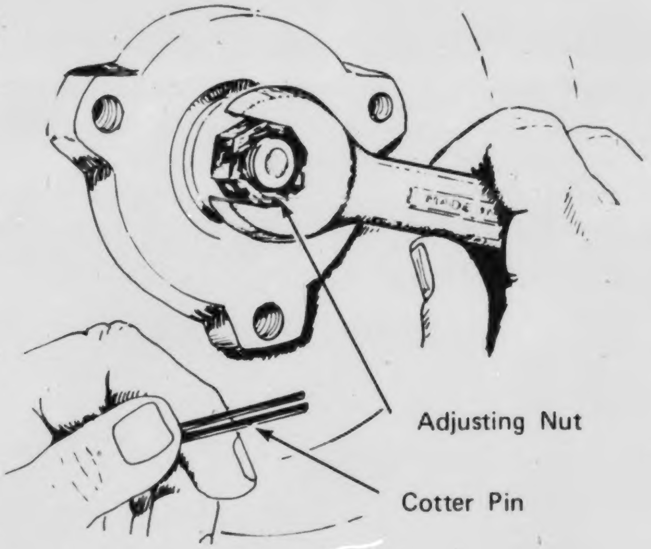
FIGURE 2b

Held With Stud Bolts


Gasket
Hub Cap
Bolts
Wheel

C. Remove cotter pin and adjusting nut (Figure 3)

FIGURE 3


Adjusting Nut
Cotter Pin

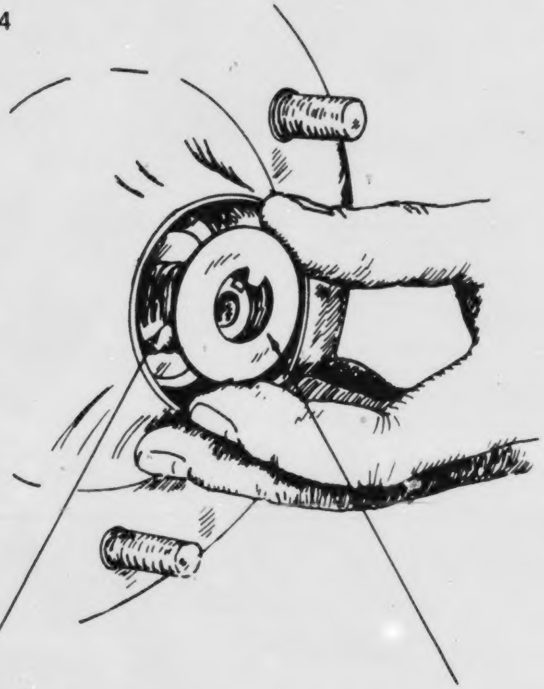
JOB SHEET #1

(NOTE: Use diagonal pliers for straightening cotter pin and for removing it. Lay all parts on a clean cloth or in a clean pan. It is very important to keep all of the bearing parts free from dirt. Once dirt enters the moving parts of a bearing, it is not easily removed, even in the cleaning solution. Do not use the hub cap as a container unless you clean it first and do not put the bearing parts on the floor.)

D. Remove thrust washer and outer bearing (Figure 4)

(NOTE: If the washer and outer bearing are not loose, shake the wheel gently to dislodge them. Hold your hand under the hub to keep the parts from falling on the floor.)

FIGURE 4

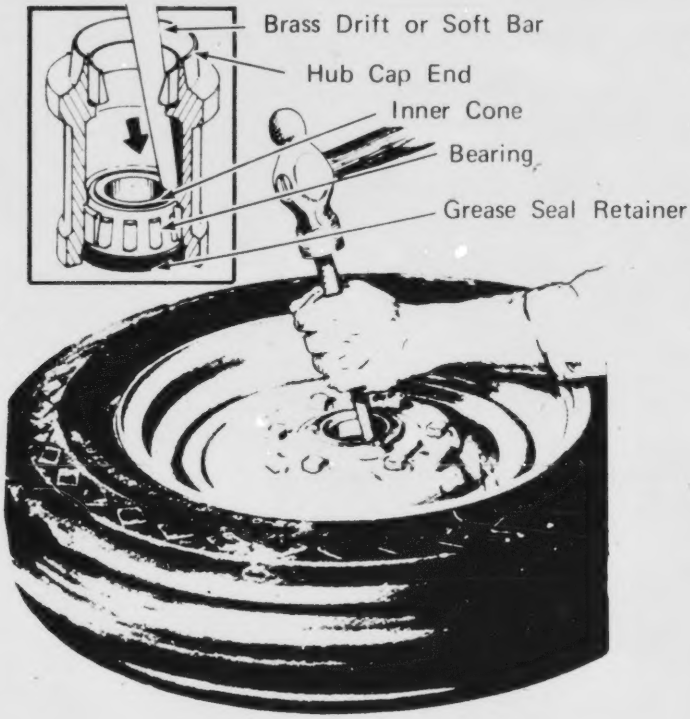

Outer Bearing Cone and Roller
Thrust Washer

JOB SHEET #1

E. Pull wheel off the spindle

(NOTE: On some tractors the grease-seal retainer is pressed into the hub and holds the rollers and inner cone in position. With this type the bearing and seal will come off with the wheel and remain in the hub until tapped out. See Figure 5. On other tractors the grease-seal retainer remains on the spindle when the wheel is removed, which leaves the inner-bearing cone free to either come off with the wheel or remain on the spindle. If you are not certain which type of grease retainer seal is used on your tractor, hold your hand so you can catch the inner bearing as you remove the wheel, in case it should be of the latter type.)

FIGURE 5


Brass Drift or Soft Bar
Hub Cap End
Inner Cone
Bearing
Grease Seal Retainer

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

JOB SHEET #2--CLEAN THE WHEEL BEARINGS

I. Tools and materials

  A. Clean rags

  B. Container with cleaning solvent

  C. Small two-inch brush

  D. Compressed air, if available

II. Procedure

  A. Wash bearings thoroughly

(NOTE: "Swish" the bearing in the cleaning solution, kerosene, or diesel fuel; use a stiff bristled brush to help loosen old grease deposits. See Figure 1a. If the inner bearing is on the spindle and can not be removed easily, clean grease seal and bearing in place. See Figure 1b.)

FIGURE 1a

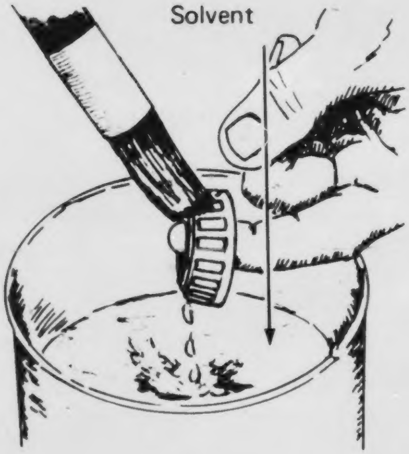
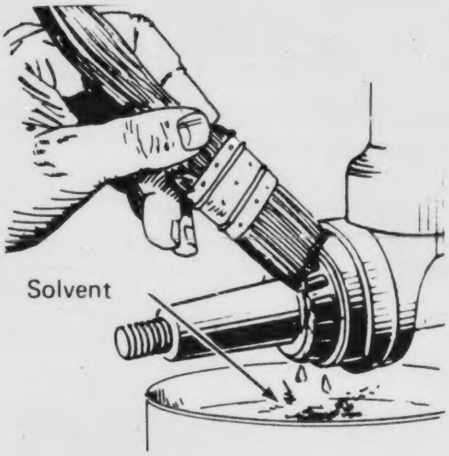


FIGURE 1b



JOB SHEET #2

B. Remove solvent from bearings and other washed parts

(NOTE: If dry compressed air is available, it may be used for drying the bearings but hold the bearing cone so the air blast will spin it. See Figure 2a. Spinning a dry bearing causes rapid wear and it may ruin both the rollers and raceways. If the air contains moisture, do not use it. Moisture blown into the bearings will cause them to rust. Drying with a clean, dry cloth is satisfactory as in Figure 2b but be sure the cloth is free of dirt, dust, and lint.)

FIGURE 2a

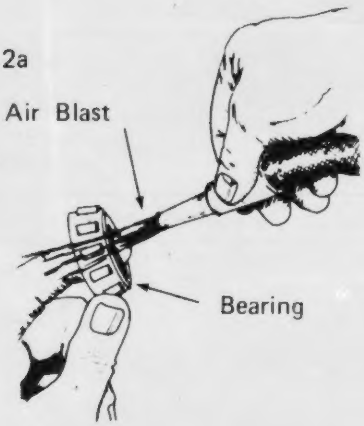
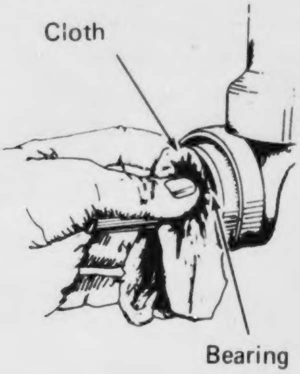


FIGURE 2b



C. Examine bearings for wear

(NOTE: If there is evidence of much wear, corrosion, or pitting, replace both parts of bearing. If inner bearing is tight on the spindle and you wish to remove it, loosen with a wood dowel and hammer. Tap lightly.)

D. Examine grease-retainer ring and seal; replace if damaged

(NOTE: If it has been damaged [ruptured, distorted, or cracked], it should be replaced particularly for wheels with bearings that are packed only once every 500 hours or once a year. It is this seal that keeps the grease in and keeps out dirt and moisture. Much damage can be done during the interval between wheel packings if the seal leaks. Some manufacturers recommend that the seal be replaced each time a wheel bearing is repacked.)

E. Clean hub, hub cap, and spindle with solvent

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

JOB SHEET #3--PACK AND ASSEMBLE THE WHEEL BEARINGS

I. Tools and materials

   A. Set of open end wrenches

   B. Diagonal pliers

   C. Clean rags

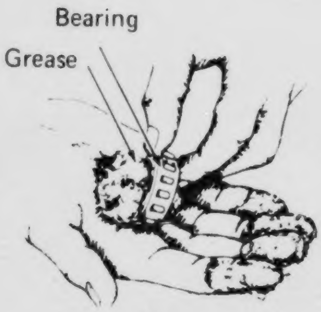
   D. Multi-purpose grease

   E. New cotter pins

II. Procedure

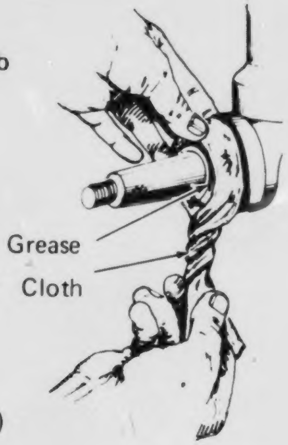
   A. Pack each bearing with grease (Figures 1a and 1b)

FIGURE 1a



(a)

FIGURE 1b



(b)

(NOTE: These are two methods of packing bearings. Place grease in hand, then push grease into bearing by pressing bearing against your palm and rotating it. Work grease entirely through bearing and between rollers. See Figure 1a. If inner bearing is left on spindle, apply about two tablespoons of grease to outer portions; wrap a clean cloth around bearing and twist ends of cloth until it binds tightly around bearing. Use hand to press grease into bearing. See Figure 1b.)

   B. Replace inner bearing and grease-retainer seal if removed originally

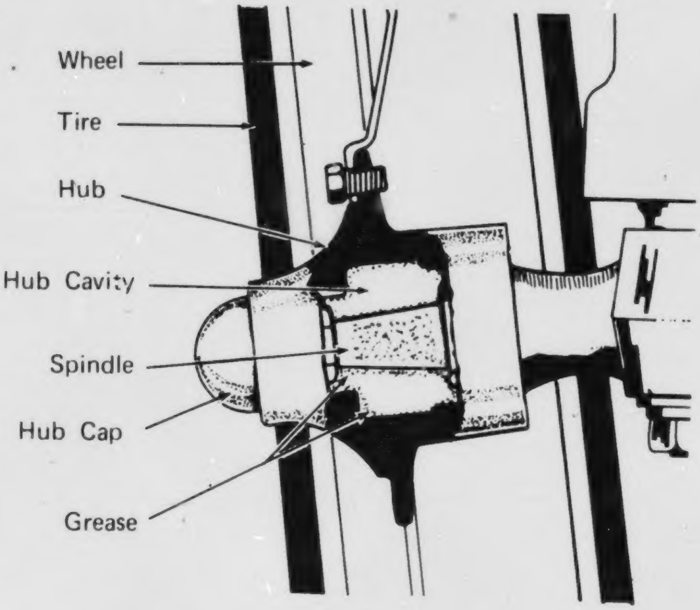
(NOTE: Replace in opposite sequence from that of removal whether being replaced on the spindle or in the hub. You may have to tap the grease-retainer seal lightly and evenly around the edges to seat it.)

JOB SHEET #3

C. Coat spindle and inside of hub with grease

(NOTE: Most manufacturers recommend only a thin coating of grease, just enough to prevent rust and to help prevent entrance of dirt and water. This leaves ample air space in the hub for the grease to expand without building up pressure which will force the grease past the seal. However, there are a few companies that insist the groove or cavity in the hub between the two roller bearings should be filled with grease. See Figure 2. Even this practice provides considerable air space around the spindle. Check your operator's manual.)

FIGURE 2



D. Position wheel on spindle and install outer bearing

(NOTE: Be extremely careful that dirt doesn't fall from the tire or wheel on the spindle or bearing.)

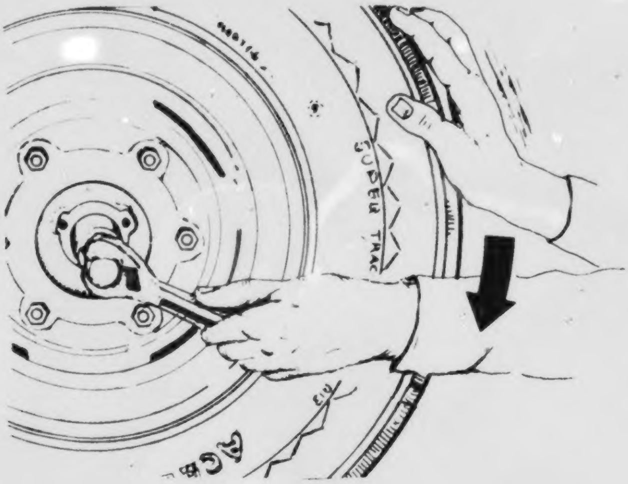
E. Install thrust washer and slotted adjusting nut

JOB SHEET #3

F. Turn wheel and tighten slotted adjusting nut until wheel drags; then loosen

(NOTE: The slotted adjusting nut is also called a "castellated" nut. Use caution while tightening to avoid overtightening. See Figure 3. Turn the wheel slowly as you tighten the nut until a slight bind is felt. The slight bind means that all surfaces are in contact. Then loosen the nut until the nearest slot (castellation) is aligned with the hole in the spindle. Some manufacturers recommend loosening the nut as much as 1/6 to 1/3 turn.)

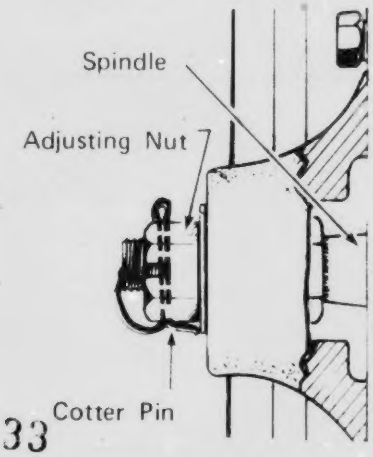
FIGURE 3



G. Lock nut with cotter pin

(NOTE: Use a new cotter pin. Insert pin, then use diagonal pliers and pull one leg of pin outward and up over the end of the spindle. See Figure 4. Cut excess off the other cotter pin leg and bend leg backwards against nut. This assures that the pin will stay in place. Do not overlook this step. If the pin is not installed, the nut will gradually loosen and the wheel will come off.)

FIGURE 4



H. Replace hub cap

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

TEST

NAME ______________________ SCORE ______________

1. Explain in writing the importance of wheel bearing service.

____

____

____

2. Select from the list below the proper service interval for wheel bearings. Place an "X" by the correct answers.

_____a. Interval varies from 500 to 1,200 hours

_____b. In the winter the bearings should be serviced more often

_____c. If tractor has a grease fitting for gun lubrication, grease daily or twice per day

3. Name three common causes of wheel bearing failures.

a. ____

b. ____

c. ____

4. Identify the components of a wheel assembly by matching the terms below with the numbers found on the following drawing.

_____a. Wheel

_____b. Cotter pin

_____c. Outer bearing cone and roller

_____d. Hub

_____e. Grease seal

_____f. Spindle

_____g. Grease seal cup

_____h. Inner bearing cone and roller

______i. Inner bearing cup

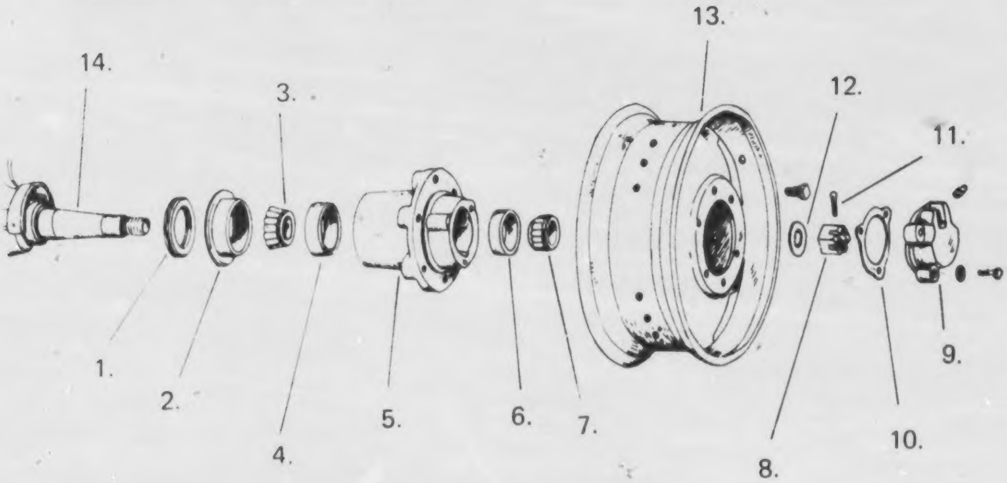
______j. Washer

______k. Adjusting nut

______l. Hub cap

______m. Gasket

______n. Outer bearing cup



5. Demonstrate the ability to:

   a. Disassemble the wheel bearings.

   b. Clean the wheel bearings.

   c. Pack and assemble the wheel bearings.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR WHEEL BEARINGS
UNIT VII

ANSWERS TO TEST

1. Explain in writing the importance of wheel bearing service.

   Due to work in dusty areas, tractor wheel bearings are often subjected to needless wear if not kept properly adjusted or lubricated

2. Select from the list below the proper service interval for wheel bearings. Place an "X" by the correct answers.

   X a. Interval varies from 500 to 1,200 hours

   ____ b. In the winter the bearings should be serviced more often

   X c. If tractor has a grease fitting for gun lubrication, grease daily or twice per day

3. Name three common causes of wheel bearing failures.

   (NOTE: Any three of the following are acceptable.)

   a. Faulty dust seal

   b. Improper lubrication

   c. Loose bearings

   d. Operating wheels underwater

   e. Operating the tractor with a heavy load on the wheel bearings

   f. Operating with bearings too tight

4. Identify the components of a wheel assembly by matching the terms below with the numbers found on the following drawing.

   13 a. Wheel

   11 b. Cotter pin

   7 c. Outer bearing cone and roller

   5 d. Hub

   1 e. Grease seal

14 f. Spindle

2 g. Grease seal cup

3 h. Inner bearing cone and roller

4 i. Inner bearing cup

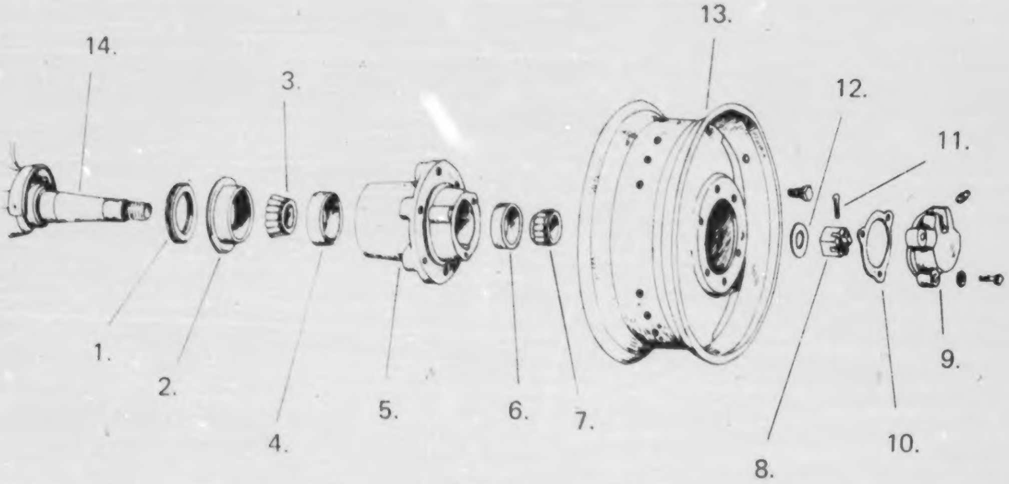
12 j. Washer

8 k. Adjusting nut

9 l. Hub cap

10 m. Gasket

6 n. Outer bearing cup



5. Demonstrate the ability to:

a. Disassemble the wheel bearings.

b. Clean the wheel bearings.

c. Pack and assemble the wheel bearings.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to name the purposes of the lubrication system within an engine and select from a list the rules to use when selecting engine oils. The student should be able to identify the types of filter assemblies and match the SAE letter designations to the API and ASTM descriptions. The student should demonstrate the ability to change crankcase oil and oil filter. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the lubrication system to the correct definitions.
2. Name the purposes of the lubrication system within an engine.
3. Select from a list the conditions that affect crankcase oil change intervals.
4. Identify the types of filter assemblies.
5. Match the SAE letter designations to the API and ASTM descriptions.
6. State the purposes of multiviscosity oils.
7. Select from a list the general rules to use when selecting engine oils.
8. List points to consider when storing and handling engine oils.
9. Demonstrate the ability to change crankcase oil and oil filter.

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Unit references:

  A. American Association for Agricultural Engineering and Vocational Agriculture. *Tractor Maintenance.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

  B. American Association for Agricultural Engineering and Vocational Agriculture. *Tractor Fuels and Lubricants.* Athens, Georgia: McCall Printing Company/Foote and Davis Division, 1970.

  C. *Fundamentals of Service: Fuels, Lubricants, and Coolants.* Moline, Illinois: John Deere Service Publications, 1970.

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

  A. Friction--Resistance to movement between any two objects placed in contact with each other

  B. Viscosity--Measure of the fluidity of an oil at a given temperature

  C. API--American Petroleum Institute

  D. SAE--Society of Automotive Engineers

  E. Oil pan--Cover on the bottom of the engine providing a reservoir for the engine oil

  F. Oil filter--Device used to strain the engine oil, thus removing abrasive particles

  G. ASTM--American Society for Testing Materials

  (NOTE: ASTM sets standards manufactured materials must meet.)

  H. MIL--Specifications prepared by the Ordinance Department of the U.S. Army, Navy, and Air Force

  I. Multiviscosity oil--Oil compounded to behave as light oil at cold temperatures and heavy oil at warm temperatures

  (NOTE: Multiviscosity oils may meet the SAE specification of four or five single grade oils.)

II. Purposes of lubrication system within an engine (Transparency 1)

  A. Lubricates moving parts to minimize power loss from friction

  B. Acts as a cooling agent to remove heat from engine parts

  C. Forms a seal between piston rings and cylinder walls

  D. Acts as a cleaning agent

  E. Absorbs shock between bearings and other parts

INFORMATION SHEET

III. Conditions that affect crankcase oil change intervals

  A. Engine design

  B. Kind of fuel used

  C. Oil capacity in relation to the size and horsepower of the engine

  D. Load temperature under which the tractor operates

  E. Dirt conditions under which the tractor operates

IV. Filter assemblies (Transparency 2)

  A. Filter bowl--Held in position with a through bolt

  B. Filter cartridge--Held in place with cap and through bolt

  C. "Spin-on" double filters--Have own outer shells

V. Oil classifications

SAE Letter Designation	API Brief Identification and Engine Service Description	ASTM Engine Oil Description
SA	*Utility Gasoline & Diesel Engine Service* Service typical of engines operated under such mild conditions that the protection afforded by compounded oils is not required. This classification has no performance requirements.	Oil without additive except that it may contain pour and/or foam depressants.
SB	*Minimum Duty Gasoline Engine Service* Service typical of engines operated under such mild conditions that only minimum protection afforded by compounding is desired. Oils designed for this service have been used since the 1930's and provide only anti-scuff capability and resistance to oil oxidation and bearing corrosion.	Provides some anti-oxidant and anti-scuff capabilities.
SC	*1964 Gasoline Engine Warranty Service* Service typical of gasoline engines in 1964 through 1967 models of passenger cars and trucks operating under engine manufacturers' warranties in effect during those model years. Oils designed for this service provide control of high and low temperature deposits, wear, rust and corrosion in gasoline engines.	Oil meeting the 1964-1967 requirements of the automobile manufacturers. Intended primarily for use in passenger cars. Provides low temperature anti-sludge and anti-rust performance.

INFORMATION SHEET

SAE Letter Designation	API Brief Identification and Engine Service Description	ASTM Engine Oil Description
SD	*1968 Gasoline Engine Warranty Service* Service typical of gasoline engines in passenger cars and trucks beginning with 1968 models and operating under engine manufacturers' warranties. Oils designed for this service provide more protection from high and low temperature engine deposits, wear, rust and corrosion in gasoline engines than oils for API Service Classification SC and may be used when oils for API Service Classification SC are recommended.	Oil meeting the requirements of the automobile manufacturers since 1968. Intended primarily for use in passenger cars. Provides low temperature anti-sludge and anti-rust performance.
CA	*Light Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty with high quality fuels. Occasionally has included gasoline engines in mild service. Oils designed for this service were widely used in the late 1940's and 1950's. These oils provide protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines when using fuels of such quality that they impose no unusual requirements for wear and deposit protection.	Oil meeting the requirements of MIL-L-2104A. For use in gasoline and naturally aspirated diesel engines operated on low sulphur fuel. The MIL-L-2104A Specification was issued in 1954.
CB	*Moderate Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels which necessitate more protection from wear and deposits. Occasionally has included gasoline engines in mild service. Oils designed for this service were introduced in 1949. Such oils provide necessary protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines with higher sulfur fuels.	Oil for use in gasoline and naturally aspirated diesel engines. Includes MIL-L-2104A oils where the diesel engine test was run using high sulfur fuel.
CC	*Moderate Duty Diesel & Gasoline Engine Service* Service typical of lightly supercharged diesel engines operated in moderate to severe duty and has included certain heavy-duty, gasoline engines. Oils designed for this service were introduced in 1961 and used in many trucks and in industrial and construction equipment and farm tractors. These oils provide protection from high temperature deposits in lightly supercharged diesels and also from rust, corrosion and low temperature deposits in gasoline engines.	Oil meeting requirements of MIL-L-2104B. Provides low temperature anti-sludge, anti-rust and lightly supercharged diesel engine performance. The MIL-L-2104B specification was issued in 1964.
CD	*Severe Duty Diesel Engine Service* Service typical of supercharged diesel engines in high-speed, high-output duty requiring highly effective control of wear and deposits. Oils designed for this service were introduced in 1955 and provide protection from bearing corrosion and from high temperature deposits in supercharged diesel engines when using fuels of a wide quality range.	Oil meeting the requirements of the Caterpillar Tractor Co. Series 3 specification. Provides moderately supercharged diesel engine performance. The Series 3 specification was established by Caterpillar in 1955. The related MIL-L-45199B specification was issued in 1968.

INFORMATION SHEET

VI. Purposes of multiviscosity oils

A. Effective at a wider range of temperatures

B. Act as a low temperature oil at low temperatures

C. Act as a high temperature oil at high temperatures

VII. Selecting engine oils

A. Use reputable brands of oil of the proper viscosity and service ratings as outlined in the operator's manual

(NOTE: If the manufacturer has a special oil which does a better job, use only that oil in your engine.)

B. Drain and change oil at recommended intervals

(NOTE: For exact intervals, see the machine operator's manual. Always drain out oil while it is hot and before the sludge settles.)

C. Select only oils which have been performance tested

D. Can mix oils carrying the same SAE specification even though obtained from different suppliers

(NOTE: Do not mix different viscosity oils, such as 10w, 20w, or 30w.)

E. Bring the engine up to normal operating temperature each time it is used

(NOTE: This will help reduce engine wear.)

F. Keep oil containers covered, sealed, and protected to prevent contamination by dirt or water

VIII. Storing and handling engine oils

A. Store oil inside whenever possible in clean, closed cabinets or rooms

(NOTE: It is best to keep oil relatively warm in the winter.)

B. Lay oil barrels on their sides if stored outside; if they can not be laid on their sides, tilt them slightly

(NOTE: Turn the barrel so that the bung is at the high side, away from any water which collects.)

INFORMATION SHEET

C. Keep oil barrel bungs drawn tightly

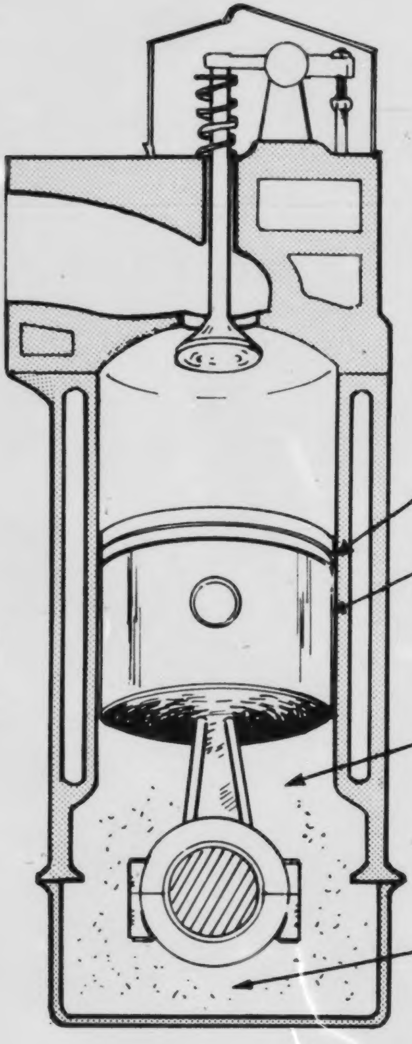
D. Rinse oil containers and funnels in solvent after use

(NOTE: Cover them to keep out dirt or store them upside down.)

E. When adding oil, clean all dirt from around the filler cap before removing it

(NOTE: Do the same before unscrewing an oil filter or a filter cap.)

Purposes of Lubricants



Seals

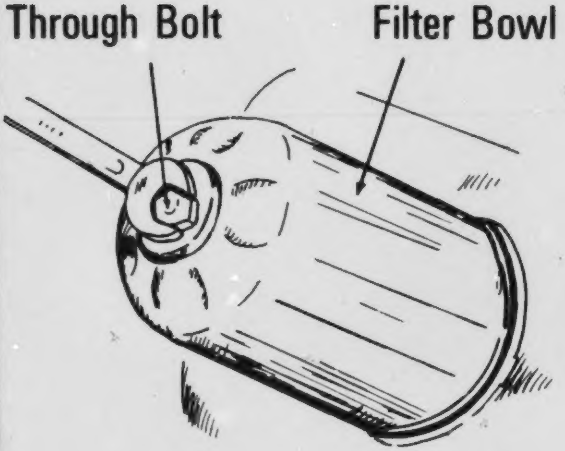
Lubricates

Reduces Rust and Corrosive Action

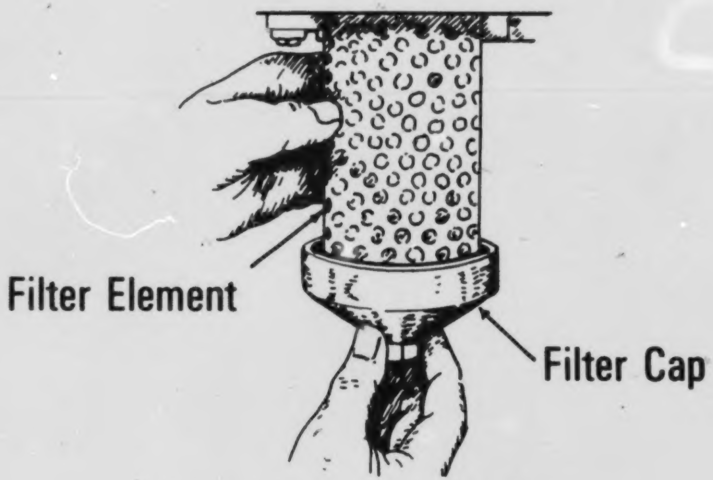
Carries Off Heat

Cleans

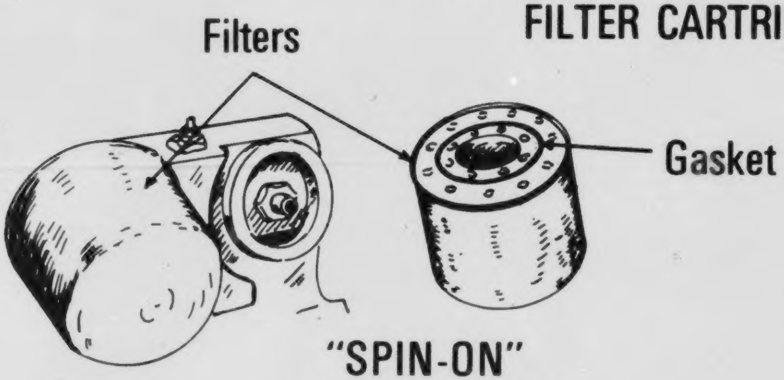
Types of Filter Assemblies


Through Bolt
Filter Bowl

FILTER BOWL


Filter Element
Filter Cap

FILTER CARTRIDGE


Filters
Gasket

"SPIN-ON"
DOUBLE FILTERS

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

JOB SHEET #1--CHANGE CRANKCASE OIL AND OIL FILTER

I. Tools and materials

A. Wrench for drain plug

B. Clean rags

C. Container for old oil

D. New oil of grade and type recommended for your tractor

E. New filter cartridge

F. Wrenches, if needed, to loosen or tighten filter bowl or cap

G. Cleaning solvent

II. Procedure

A. Operate engine until thoroughly heated

(NOTE: Oil will drain more completely while hot; more of the contaminants are removed while the oil is still agitated. If crankcase is drained while oil is cold, some of the more highly contaminated oil may remain in the engine.)

B. Remove drain plug; clean if it is the magnetic type

(NOTE: Use a wrench that fits the drain plug, not a pair of pliers. Pliers will gradually round off the corners of the plug until it will be difficult to either remove or tighten it.)

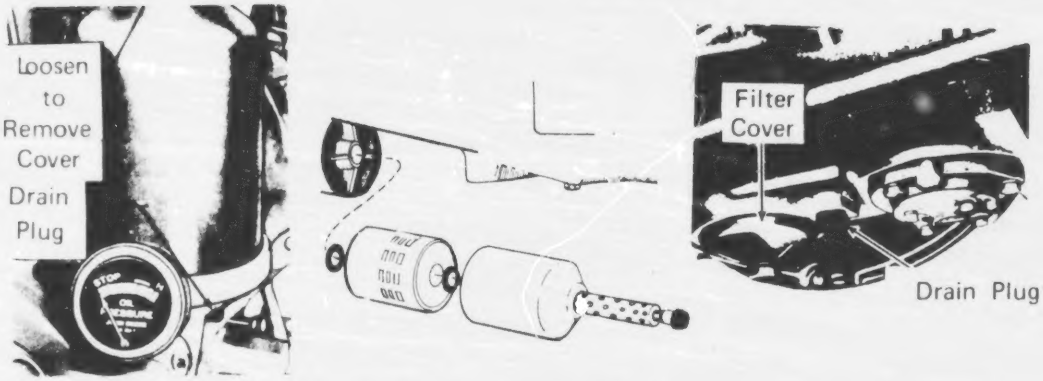
C. Allow crankcase to drain for several minutes

(NOTE: This allows time for oil to drain from various parts of the engine. This is important in order to remove as much dirt laden oil as possible. If it is time for an oil filter change, remove the filter while oil is being drained.)

JOB SHEET #1

D. Find location of oil filter (Figure 1)

FIGURE 1

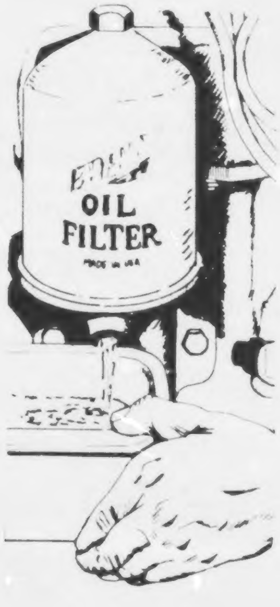

Loosen to Remove Cover
Drain Plug
STOP
OIL PRESSURE
Filter Cover
Drain Plug

Side of Engine Under Engine Crankcase Inside Crankcase

E. Wipe dirt from filter and from around filter area

F. Remove drain plug (if provided) from base of filter and catch oil in can or drain pan (Figure 2)

FIGURE 2


OIL FILTER
MADE IN USA

JOB SHEET #1

(NOTE: Removal of the plug drains out much of the dirt ahead of removing the filter element. Some filters are not equipped with drain plugs; draining action is secured when the bowl or filter body is removed.)

G. Loosen filter bowl or cover and remove

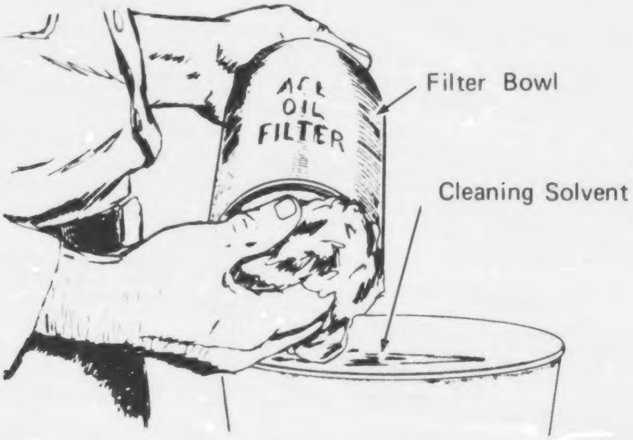
H. Remove old filter cartridge and discard it

(NOTE: Do not try to clean the old filter element unless it is the old style screen type. Abrasives embedded in filter material are difficult or impossible to remove.)

I. Clean inside of filter bowl and base with cleaning solvent (Figure 3)

(NOTE: This is to remove dirt deposits. Use a clean cloth and clean solvent solution.)

FIGURE 3



J. Replace and tighten drain plug if one was removed

K. Install new gasket if supplied with filter

(NOTE: New gaskets are usually supplied with new filters. However, if a new gasket is not available, examine the old one. It may still be usable. With a "spin-on" type of filter you can reduce the chance of damaging the gasket by first applying a slight amount of crankcase oil or grease to the gasket before the filter is screwed into position.)

JOB SHEET #1

L. Install new filter unit

(NOTE: If your replacement cartridge is the type that is installed in a filter bowl, rotate the element slightly to help it become sealed. Do not apply much pressure because the seals can be easily damaged. If you have a spin-on filter that uses a rubber gasket, turn the filter on until the gasket contacts the base; then tighten no more than one-half turn or as directed on filter. This keeps from overtightening which distorts the gasket and causes leaks.)

M. Replace filter bowl (if of that type) and tighten in place

(NOTE: Tighten just enough to form a seal. Too much tightening damages the gasket or gaskets.)

N. Replace drain plug

(NOTE: If drain plug is equipped with a gasket, be sure it is in place on the drain plug. Tighten the plug. Do not overtighten or cross thread. If filter element was removed, install a new one.)

O. Refill crankcase with new oil

(NOTE: Be extra careful that the tops of oil cans are thoroughly clean as in Figure 4. Check the funnel or any containers you may be using to make certain they are free of dirt. See Figure 5. No amount of filtering will completely take the place of the care you use when you refill with new oil. One to three extra quarts will probably be needed, if you changed oil filters, to recharge the new filter. Check the operator's manual for the requirements of your tractor. Use the viscosity and type of oil recommended in your operator's manual.)

FIGURE 4

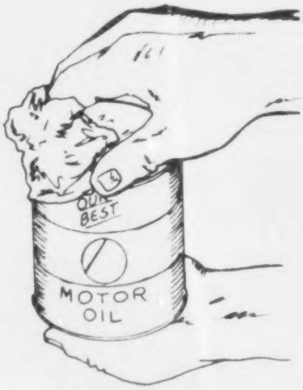
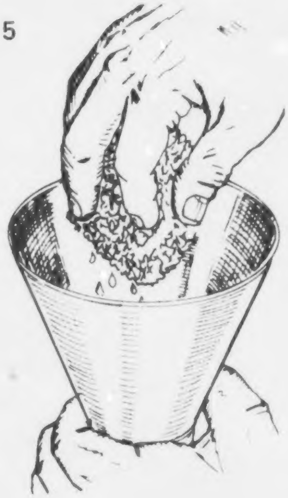


FIGURE 5



JOB SHEET #1

P. Start engine and operate it for a few minutes at a low rpm (revolutions per minute)

(NOTE: This gives the oil an opportunity to fill the oil filter and establish a true level on the dip stick. Also check the pressure gauge to make certain the oil pump is working properly.)

Q. Check for oil leaks

(NOTE: Observe area around drain plug and around filter element if filter was changed.)

R. Check oil level on dip stick

(NOTE: If oil is not to the "full" line, add until it reaches that level. Do not overfill; this increases oil consumption and causes oil foaming.)

S. Store used oil in a drum or small closed container

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

TEST

NAME ______________________________ SCORE ____________________

1. Match the terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided.

______ a. Measure of the fluidity of an oil at a given temperature

______ b. Cover on the bottom of the engine providing a reservoir for the engine oil

______ c. American Petroleum Institute

______ d. Society of Automotive Engineers

______ e. Resistance to movement between any two objects placed in contact with each other

______ f. Device used to strain the engine oil, thus removing abrasive particles

______ g. American Society for Testing Materials

______ h. Specifications prepared by the Ordinance Department of the U.S. Army, Navy, and Air Force

______ i. Oil compounded to behave as light oil at cold temperatures and heavy oil at warm temperatures

1. Friction
2. Viscosity
3. API
4. SAE
5. Oil pan
6. Oil filter
7. MIL
8. ASTM
9. Multiviscosity oil

2. Name three purposes of the lubrication system within an engine.

a. ____

b. ____

c. ____

3. Select from the list below the conditions that affect crankcase oil change intervals. Place an "X" by the correct conditions.

______ a. Kind of fuel used

______ b. Dirt conditions under which the tractor operates ______c. Oil capacity in relation to the size and horsepower of the engine

______d. Price of oil and filter

______e. Load temperature under which the tractor operates

______f. Skill of operator

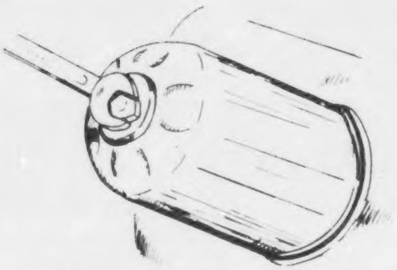
4. Identify the types of filter assemblies by matching the assemblies below with the proper illustration.

______a. Filter bowl--Held in position with a through bolt

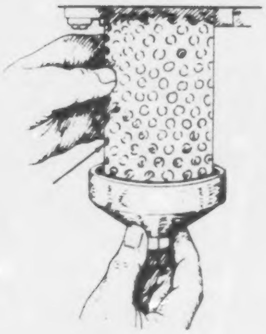
______b. "Spin-on" double filters--Have own outer shells

______c. Filter cartridge--Held in place with cap and through bolt

1.



2.



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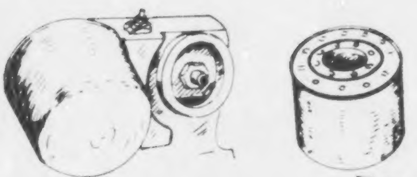


5. Match the SAE letter designations on the right to the proper API and ASTM descriptions by placing the appropriate numbers in the blanks provided.

a. ______	*Moderate Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels which necessitate more protection from wear and deposits. Occasionally has included gasoline engines in mild service. Oils designed for this service were introduced in 1949. Such oils provide necessary protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines with higher sulfur fuels.	Oil for use in gasoline and naturally aspirated diesel engines. Includes MIL-L-2104A oils where the diesel engine test was run using high sulfur fuel.
b. ______	*Light Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty with high quality fuels. Occasionally has included gasoline engines in mild service. Oils designed for this service were widely used in the late 1940's and 1950's. These oils provide protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines when using fuels of such quality that they impose no unusual requirements for wear and deposit protection.	Oil meeting the requirements of MIL-L-2104A. For use in gasoline and naturally aspirated diesel engines operated on low sulphur fuel. The MIL-L-2104A Specification was issued in 1954.
c. ______	*Minimum Duty Gasoline Engine Service* Service typical of engines operated under such mild conditions that only minimum protection afforded by compounding is desired. Oils designed for this service have been used since the 1930's and provide only anti-scuff capability, and resistance to oil oxidation and bearing corrosion.	Provides some anti-oxidant and anti-scuff capabilities.
d. ______	*Severe Duty Diesel Engine Service* Service typical of supercharged diesel engines in high-speed, high-output duty requiring highly effective control of wear and deposits. Oils designed for this service were introduced in 1955, and provide protection from bearing corrosion and from high temperature deposits in supercharged diesel engines when using fuels of a wide quality range.	Oil meeting the requirements of the Caterpillar Tractor Co. Series 3 specification. Provides moderately supercharged diesel engine performance. The Series 3 specification was established by Caterpillar in 1955. The related MIL-L-45199B specification was issued in 1968.
e. ______	*Moderate Duty Diesel & Gasoline Engine Service* Service typical of lightly supercharged diesel engines operated in moderate to severe duty and has included certain heavy-duty, gasoline engines. Oils designed for this service were introduced in 1961 and used in many trucks and in industrial and construction equipment and farm tractors. These oils provide protection from high temperature deposits in lightly supercharged diesels and also from rust, corrosion and low temperature deposits in gasoline engines.	Oil meeting requirements of MIL-L-2104B. Provides low temperature anti-sludge, anti-rust and lightly supercharged diesel engine performance. The MIL-L-2104B specification was issued in 1964.
f. ______	*1968 Gasoline Engine Warranty Service* Service typical of gasoline engines in passenger cars and trucks beginning with 1968 models and operating under engine manufacturers' warranties. Oils designed for this service provide more protection from high and low temperature engine deposits, wear, rust and corrosion in gasoline engines than oils for API Service Classification SC and may be used when oils for API Service Classification SC are recommended.	Oil meeting the requirements of the automobile manufacturers since 1968. Intended primarily for use in passenger cars. Provides low temperature anti-sludge and anti-rust performance.
g. ______	*1964 Gasoline Engine Warranty Service* Service typical of gasoline engines in 1964 through 1967 models of passenger cars and trucks operating under engine manufacturers' warranties in effect during those model years. Oils designed for this service provide control of high and low temperature deposits, wear, rust and corrosion in gasoline engines.	Oil meeting the 1964-1967 requirements of the automobile manufacturers. Intended primarily for use in passenger cars. Provides low temperature anti-sludge and anti-rust performance.
h. ______	*Utility Gasoline & Diesel Engine Service* Service typical of engines operated under such mild conditions that the protection afforded by compounded oils is not required. This classification has no performance requirements.	Oil without additive except that it may contain pour and/or foam depressants.

1. CA
2. CC
3. CB
4. CD
5. SA
6. SB
7. SC
8. SD

6. State the purposes of multiviscosity oils.

   a. ______________________________

   b. ______________________________

   c. ______________________________

7. Select from the list below the general rules to use when selecting engine oils. Place an "X" by the proper rules.

   ______a. Use reputable brands of oil of the proper viscosity and service ratings as outlined in the operator's manual

   ______b. Drain and change oil at the beginning of each winter, spring, and summer season

   ______c. Select only oils which have been performance tested

   ______d. Can mix oils carrying the same MIL specification if obtained from different suppliers

8. List three points to consider when storing and handling engine oils.

   a. ______________________________

   b. ______________________________

   c. ______________________________

9. Demonstrate the ability to change crankcase oil and oil filter.

   (NOTE: If the above activity has not been accomplished prior to the test, ask the instructor when it should be completed.)

SERVICING TRACTOR LUBRICATION SYSTEM
UNIT VIII

ANSWERS TO TEST

1. Match the terms on the right to the definitions on the left by placing the appropriate numbers in the blanks provided.

2 a. Measure of the fluidity of an oil at a given temperature

5 b. Cover on the bottom of the engine providing a reservoir for the engine oil

3 c. American Petroleum Institute

4 d. Society of Automotive Engineers

1 e. Resistance to movement between any two objects placed in contact with each other

6 f. Device used to strain the engine oil, thus removing abrasive particles

8 g. American Society for Testing Materials

7 h. Specifications prepared by the Ordinance Department of the U.S. Army, Navy, and Air Force

9 i. Oil compounded to behave as light oil at cold temperatures and heavy oil at warm temperatures

1. Friction
2. Viscosity
3. API
4. SAE
5. Oil pan
6. Oil filter
7. MIL
8. ASTM
9. Multiviscosity oil

2. Name three purposes of the lubrication system within an engine.

(NOTE: Any three of the following are acceptable.)

a. Lubricates moving parts to minimize power loss from friction

b. Acts as a cooling agent to remove heat from engine parts

c. Forms a seal between piston rings and cylinder walls

d. Acts as a cleaning agent

e. Absorbs shock between bearings and other parts

3. Select from the list below the conditions that affect crankcase oil change intervals. Place an "X" by the correct conditions.

X a. Kind of fuel used

X b. Dirt conditions under which the tractor operates

X c. Oil capacity in relation to the size and horsepower of the engine

______ d. Price of oil and filter

X e. Load temperature under which the tractor operates

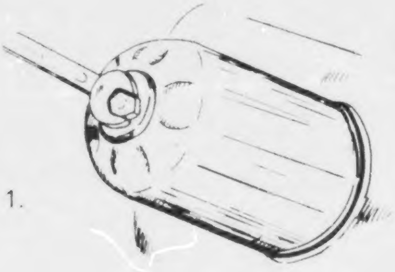
______ f. Skill of operator

4. Identify the types of filter assemblies by matching the assemblies below with the proper illustration.

1 a. Filter bowl--Held in position with a through bolt

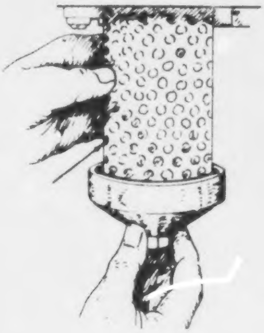
3 b. "Spin-on" double filters--Have own outer shells

2 c. Filter cartridge--Held in place with cap and through bolt

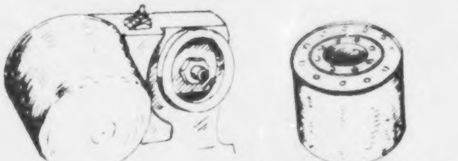


1.

2.



3.



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a. 3	*Moderate Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels which necessitate more protection from wear and deposits. Occasionally has included gasoline engines in mild service. Oils designed for this service were introduced in 1949. Such oils provide necessary protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines with higher sulfur fuels.	Oil for use in gasoline and naturally aspirated diesel engines. Includes MIL-L-2104A oils where the diesel engine test was run using high sulfur fuel.
b. 1	*Light Duty Diesel Engine Service* Service typical of diesel engines operated in mild to moderate duty with high quality fuels. Occasionally has included gasoline engines in mild service. Oils designed for this service were widely used in the late 1940's and 1950's. These oils provide protection from bearing corrosion and from high temperature deposits in normally aspirated diesel engines when using fuels of such quality that they impose no unusual requirements for wear and deposit protection.	Oil meeting the requirements of MIL-L-2104A. For use in gasoline and naturally aspirated diesel engines operated on low sulphur fuel. The MIL-L-2104A Specification was issued in 1954.
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d. 4	*Severe Duty Diesel Engine Service* Service typical of supercharged diesel engines in high-speed, high-output duty requiring highly effective control of wear and deposits. Oils designed for this service were introduced in 1955, and provide protection from bearing corrosion and from high temperature deposits in supercharged diesel engines when using fuels of a wide quality range.	Oil meeting the requirements of the Caterpillar Tractor Co. Series 3 specification. Provides moderately supercharged diesel engine performance. The Series 3 specification was established by Caterpillar in 1955. The related MIL-L-45199B specification was issued in 1968.
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1. CA
2. CC
3. CB
4. CD
5. SA
6. SB
7. SC
8. SD

6. State the purposes of multiviscosity oils.

   a. Effective at a wider range of temperatures

   b. Act as a low temperature oil at low temperatures

   c. Act as a high temperature oil at high temperatures

7. Select from the list below the general rules to use when selecting engine oils. Place an "X" by the proper rules.

   __X__ a. Use reputable brands of oil of the proper viscosity and service ratings as outlined in the operator's manual

   _____ b. Drain and change oil at the beginning of each winter, spring, and summer season

   __X__ c. Select only oils which have been performance tested

   _____ d. Can mix oils carrying the same MIL specification if obtained from different suppliers

8. List three points to consider when storing and handling engine oils.

   (NOTE: Any three of the following are acceptable.)

   a. Store oil inside whenever possible in clean, closed cabinets or rooms

   b. Lay oil barrels on their sides if stored outside; if they can not be laid on their sides, tilt them slightly

   c. Keep oil barrel bungs drawn tightly

   d. Rinse oil containers and funnels in solvent after use

   e. When adding oil, clean all dirt from around the filler cap before removing it

9. Demonstrate the ability to change crankcase oil and oil filter.

   (NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the proper servicing of a tractor hydraulic system and demonstrate the skills in servicing a tractor hydraulic system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Explain in writing the importance of proper servicing of the tractor hydraulic system.
2. List uses for hydraulic systems on tractors.
3. Name the ways dirt is kept from entering the hydraulic system.
4. Select from a list the most common types of main filters.
5. List the contaminants that cause damage to the hydraulic system.
6. Name the types of hydraulic fluids used in hydraulic systems.
7. List the most important factors in prolonging the life of a hydraulic system.
8. Demonstrate the ability to:
    a. Service the filter of a tractor hydraulic system.
    b. Service the screen of a tractor hydraulic system.
    c. Service the breather of a tractor hydraulic system.
    d. Change the fluid in the main system of a tractor hydraulic system.

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  (NOTE: Refer to manufacturer's operator's manual for all specifications.)

  G. Give test.

II. Unit references:

  A. *Tractor Maintenance.* Athens, Georgia: American Association for Vocational Instructional Materials, 1975.

  B. *Hydraulic Systems for Tractors and Other Mobile Equipment: Care and Operation.* Vol. 1. Athens, Georgia: American Association for Vocational Instructional Materials, 1974.

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

INFORMATION SHEET

I. Importance of properly servicing the tractor hydraulic system--Properly serviced hydraulic system will last longer and give better service; most important things are to keep the fluid clean, keep the proper amount of fluid in the system, keep proper type of fluid in system, and change fluid according to manufacturer's recommendations

II. Different uses for hydraulic systems on tractors (Transparency 1)

   A. Power brakes

   B. Torque converter

   C. Power steering

   D. Implement control system

   E. Hydraulically operated transmission

   F. Hydraulic motor

   (NOTE: Hydraulic motors are generally not used on tractors. Instead, they are often used for small, self-propelled equipment or to raise and lower various pieces of equipment.)

III. Ways dirt is kept from entering the hydraulic system

   A. Main filter

   B. Pump screen filter

   C. Breather filter

   D. Replacing coupling plugs when not in use

IV. Most common types of main filters

   A. Full flow

   (NOTE: All of the fluid in the system flows through this type of filter.)

   B. Bypass

   (NOTE: This filter is smaller and not as effective as the full flow filter, allowing only part of the fluid to go through the filter.)

INFORMATION SHEET

V. Contaminants that cause damage to the hydraulic system

   A. Field dust

   B. Rust particles

   C. Moisture from condensation

   D. Improper type of fluid

VI. Types of hydraulic fluids used in hydraulic systems (Transparency 2)

   A. Gear oils

   B. Automatic transmission fluids

   C. Special oils and fluids from tractor manufacturers

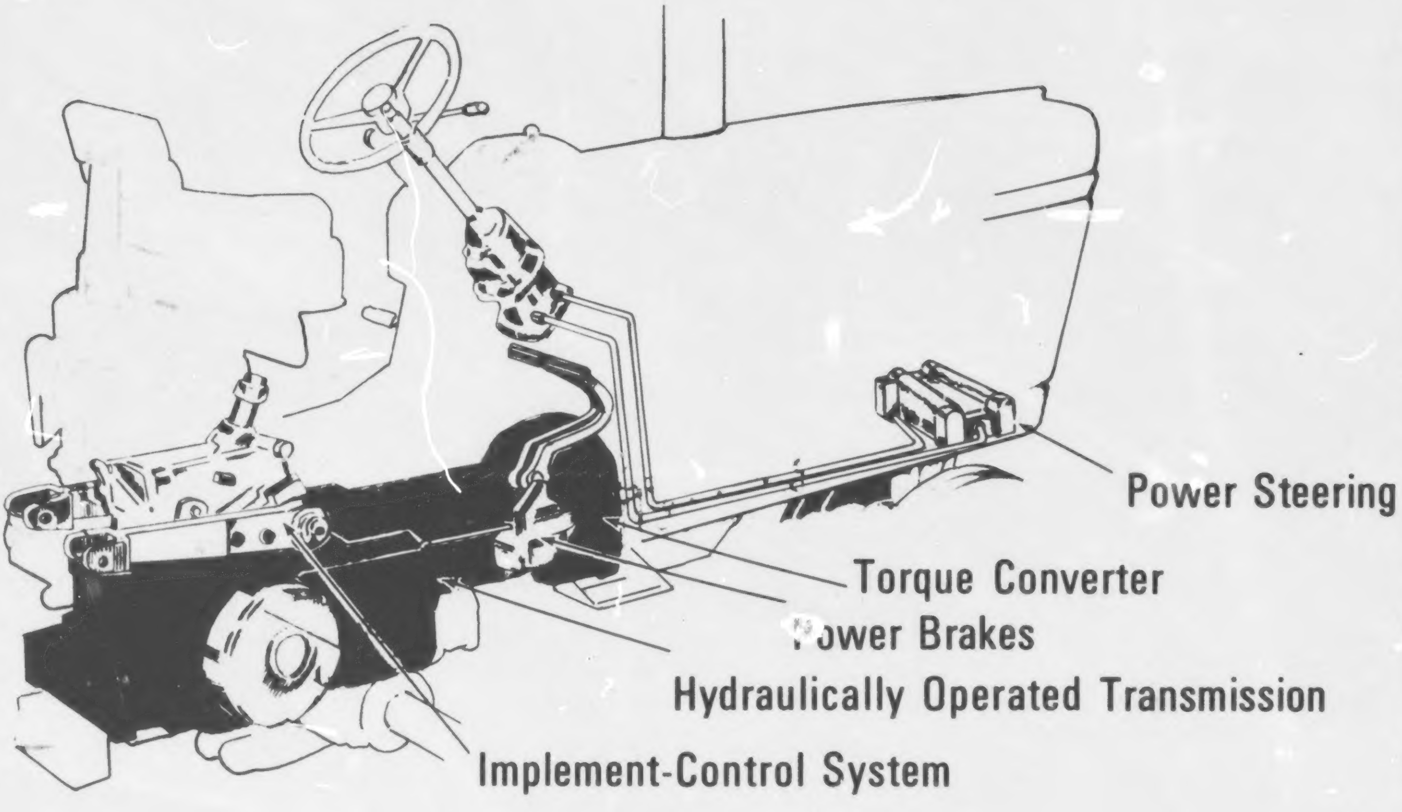
   D. Crankcase oils

VII. Most important factors in prolonging the life of a hydraulic system

   A. Clean fluid

   B. Proper type of fluid

Types of Hydraulic Systems



Power Steering

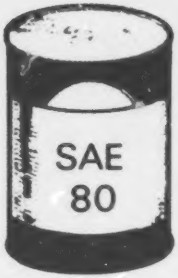
Torque Converter

Power Brakes

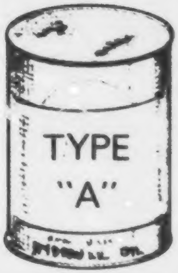
Hydraulically Operated Transmission

Implement-Control System

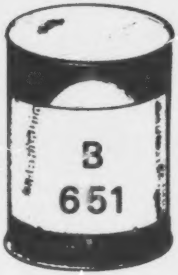
Types of Hydraulic Fluids



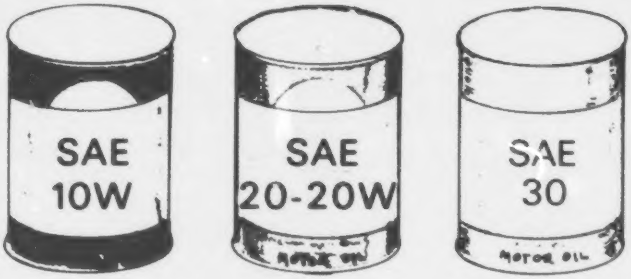
Gear Lubricant


TYPE
"A"
HYDRAULIC OIL

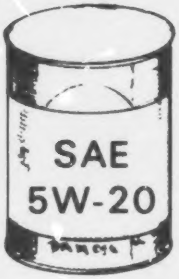
Hydraulic Fluid



Special Oils


SAE
10W
SAE
20-20W
MOTOR OIL
SAE
30
MOTOR OIL

Single-Grade Crankcase Oils



Multi-Grade Crankcase Oil

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

JOB SHEET #1--SERVICE THE FILTER OF A TRACTOR HYDRAULIC SYSTEM

I. Tools and materials

A. Clean cloths

B. Container with solvent

C. Box-end wrenches

D. Container for old oil

E. Flushing oil (if needed)

F. Hydraulic oil, type and grade recommended for your tractor

II. Procedure

A. Select the proper filter replacement

(NOTE: If your filter has a replaceable element, select only the element [Figure 1]. If your filter is the cannister type, select the cannister [Figure 2]. Refer to operator's manual)

FIGURE 1

Pleated Fiber Element

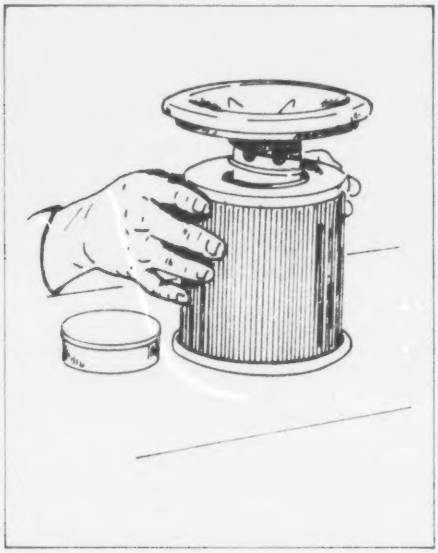
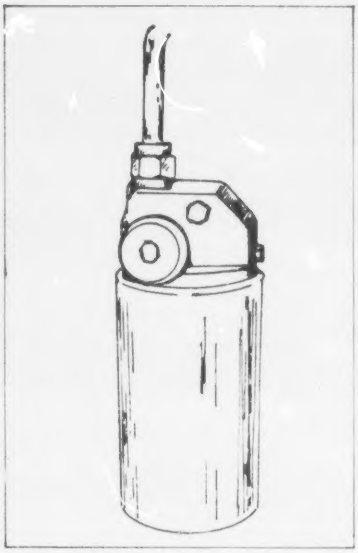


FIGURE 2

Cannister Type Filter



JOB SHEET #1

B. Clean area around filter

C. Remove filter

D. Clean filter holder, if applicable, and replace gasket

E. Replace filter

(NOTE: Handle filters with care. A small amount of damage can reduce the efficiency to a large degree.)

F. Operate system and check for leaks

G. Check fluid level

(NOTE: Fluid level may be checked by a dipstick [Figure 3], an oil level plug [Figure 4], or a sight gauge.)

FIGURE 3

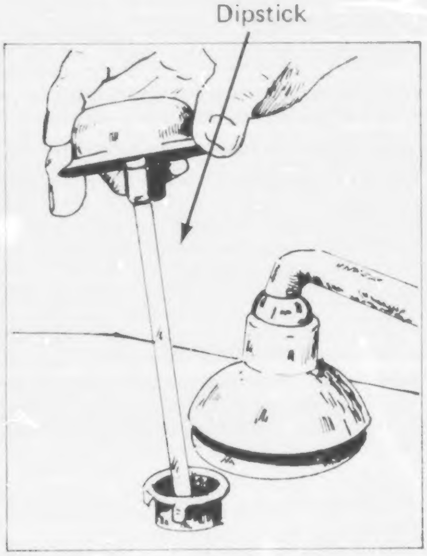
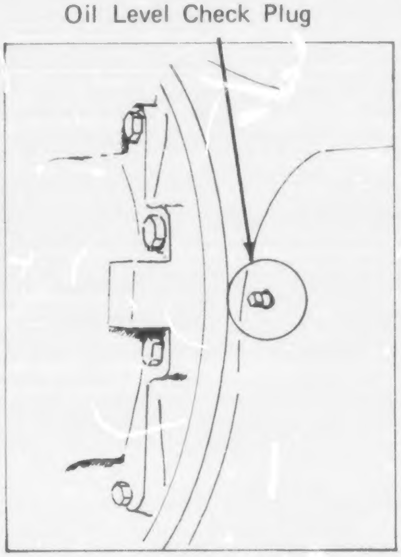


FIGURE 4



SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

JOB SHEET #2--SERVICE THE SCREEN OF A TRACTOR HYDRAULIC SYSTEM

I. Tools and materials

A. Nylon brush

B. Container with cleaning solvent

C. Operator's manual

D. Box-end wrenches

E. Container for old oil

F. Flushing oil (if needed)

G. Hydraulic oil, type and grade recommended for your tractor

II. Procedure

A. Locate the pump screen

(NOTE: Refer to operator's manual.)

B. Remove screen

(NOTE: On some systems it is necessary to drain the fluid.)

C. Clean the screen

(NOTE: Use hydraulic fluid and a nylon brush. Do not use rags that will leave lint on the screen and do not use gasoline. If cleaning solvent is used, thoroughly dry with air pressure or allow to stand until all solvent has evaporated.)

D. Reinstall screen

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

JOB SHEET #3--SERVICE THE BREATHER OF A TRACTOR HYDRAULIC SYSTEM

I. Tools and materials

- A. Clean cloths
- B. Operator's manual
- C. Hydraulic fluid
- D. Box-end wrenches

II. Procedure

- A. Remove breather filter

  (NOTE: Refer to operator's manual.)
- B. Clean filter in hydraulic fluid
- C. Reinstall breather filter

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

JOB SHEET #4--CHANGE THE FLUID IN THE MAIN SYSTEM OF A TRACTOR HYDRAULIC SYSTEM

(NOTE: This system has its own fluid supply.)

I. Tools and materials

- A. Clean cloths
- B. Container with cleaning solvent
- C. Box-end wrenches
- D. Container for old oil
- E. Flushing oil (if needed)
- F. Hydraulic oil (amount, type, and grade recommended for your tractor)
- G. Operator's manual

II. Procedure

A. Operate the system until the fluid is thoroughly heated

(NOTE: This helps drainage and mixes dirt and contaminants with fluid to be drained.)

B. Locate tractor on a level surface

C. Position lower links or three-point hitch to lowest position; independent cylinder should be fully closed

(NOTE: Check procedure in operator's manual.)

D. Drain fluid from reservoir(s)

(NOTE: Loosen filler plug for faster drainage.)

(CAUTION: If fluid is milky, this usually indicates water in fluid. Consult local implement or service center.)

E. Service filter, screens, and breather

F. Reinstall drain plug(s)

(NOTE: Some manufacturers recommend flushing the system at this time. Follow manufacturer's recommendations.)

JOB SHEET #4

G. Remove filler cap or plug and add the proper type of hydraulic fluid to the proper level

H. Replace filler cap

I. Start engine and operate lift through several cycles to remove the air from the system

J. Recheck fluid level

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

TEST

NAME ______________________ SCORE ______________________

1. Explain in writing the importance of properly servicing the tractor hydraulic system.

____

____

____

____

____

2. List four uses for hydraulic systems on tractors.

a. ____

b. ____

c. ____

d. ____

3. Name the ways dirt is kept from entering the hydraulic system.

a. ____

b. ____

c. ____

4. Select from the list below the most common types of main filters. Place an "X" by the correct answers.

_____a. Full flow

_____b. Paper

_____c. Bypass

_____d. Plastic

_____e. Metal

5. List the contaminants that cause damage to the hydraulic system.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

6. Name the types of hydraulic fluids used in hydraulic systems.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

7. List the most important factors in prolonging the life of a hydraulic system.

   a. ______________________________

   b. ______________________________

8. Demonstrate the ability to:

   a. Service the filter of a tractor hydraulic system.

   b. Service the screen of a tractor hydraulic system.

   c. Service the breather of a tractor hydraulic system.

   d. Change the fluid in the main system of a tractor hydraulic system.

   (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SERVICING TRACTOR HYDRAULIC SYSTEM
UNIT IX

ANSWERS TO TEST

1. Explain in writing the importance of properly servicing the tractor hydraulic system.

   Properly serviced hydraulic system will last longer and give better service; most important things are to keep the fluid clean, keep the proper amount of fluid in the system, keep proper type of fluid in system, and change fluid according to manufacturer's recommendations

2. List four uses for hydraulic systems on tractors.

   (NOTE: Any four of the following are acceptable.)

   a. Power brakes

   b. Torque converter

   c. Power steering

   d. Implement control system

   e. Hydraulically operated transmission

   f. Hydraulic motor

3. Name three ways dirt is kept from entering the hydraulic system.

   (NOTE: Any three of the following are acceptable.)

   a. Main filter

   b. Pump screen filter

   c. Breather filter

   d. Replacing coupling plugs when not in use

4. Select from the list below the most common types of main filters. Place an "X" by the correct answers.

   X a. Full flow

   _____ b. Paper

   X c. Bypass

   _____ d. Plastic

   _____ e. Metal

5. List the contaminants that cause damage to the hydraulic system.
    a. Field dust
    b. Rust particles
    c. Moisture from condensation
    d. Improper type of fluid
6. Name the types of hydraulic fluids used in hydraulic systems.
    a. Gear oils
    b. Automatic transmission fluids
    c. Special oils and fluids from tractor manufacturers
    d. Crankcase oils
7. List the most important factors in prolonging the life of a hydraulic system.
    a. Clean fluid
    b. Proper type of fluid
8. Demonstrate the ability to:
    a. Service the filter of a tractor hydraulic system.
    b. Service the screen of a tractor hydraulic system.
    c. Service the breather of a tractor hydraulic system.
    d. Change the fluid in the main system of a tractor hydraulic system.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

[redacted]

ELECTRICAL SAFETY
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to demonstrate safe practices in working with electricity to protect life and property. The student should be able to recognize danger areas when surveying the home farm. This knowledge will be evidenced through demonstration and by scoring 100 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with electrical safety to the correct definitions.
2. Name sources of electrical defects in equipment.
3. Name major causes of electrical accidents.
4. Discuss ways to free someone receiving electrical shock.
5. Discuss in a short paragraph first aid for a person who has just received electrical shock.
6. Discuss in a short paragraph factors contributing to death from electrical shock.
7. Identify types of circuit protection devices.
8. Name signs that wiring is out-of-date.
9. Name reasons for circuit failure.
10. Survey home farm for safe and unsafe electrical conditions.

ELECTRICAL SAFETY
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet, assignment sheet, and copy of the NEC.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Counsel with students about safe and unsafe working conditions of electricity.

   G. Obtain figures from National Safety Council, 444 N. Michigan Avenue, Chicago, Illinois 60617, on danger and damage caused by improperly using electricity and electrical equipment.

   H. Give test.

II. Unit references:

   A. *Simplified Electric Wiring Handbook*. Chicago: Sears-Roebuck and Company.

   B. Brown, Robert H. *Farm Electrification*. New York: McGraw-Hill Book Company, Inc.

   C. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook*. Danville, Illinois: The Interstate Printers and Publishers, Inc.

   D. *Farm Electricity*. State of Tennessee, Department of Education, Division of Vocational Education.

   E. *Basic Electricity and Practical Wiring Lessons*. University Park: Pennsylvania State University, College of Agriculture, Department of Agricultural Education.

   F. Recht, J. L. *Accident Facts*. Chicago, Illinois: National Safety Council.

   G. *National Electrical Code*. Boston, Massachusetts: National Fire Protection Association.

   H. *Fundamentals of Service: Electrical Systems.* 2nd ed. Moline, Illinois: Deere and Company, 1972.

ELECTRICAL SAFETY
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Fuse--Safety device which breaks the flow of electrical current when a circuit becomes overloaded by burning out of a metal strip

(NOTE: A fuse must be replaced when blown. Fuses are made of a bimetal strip which melts or breaks to break the circuit.)

B. National Electrical Code--Handbook that sets minimum standards for wiring and materials

C. Test lamp--Tool used to check short circuits, hot lines, and voltages

D. Fusetron--Double element time delay fuse designed to withstand momentary overloads

E. Grounded wire--Green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from hot to ground in a shorted piece of equipment

F. Circuit--Completed path through which electricity flows

G. Circuit breaker--Safety device which breaks the flow of electrical current when a circuit becomes overloaded by tripping a breaker switch

(NOTE: A circuit breaker may be reset. A circuit breaker contains a bimetal strip that overheats and trips the breaker.)

H. Ground fault--Unintended voltage leak to the ground

(NOTE: To avoid ground fault a ground fault interrupter, which detects any unintended voltage leak to the ground, should be installed.)

II. Sources of electrical defects in equipment (Transparency 1)

A. Ground wire missing, broken, improperly connected, or not connected at all

(CAUTION: Never remove ground prong on equipment cords.)

B. Open conduits; switch boxes damaged or worn

C. Worn, wet, or oily insulation causing short circuits

INFORMATION SHEET

- D. Defective switches, receptacles, extension or lamp cords, and lamp sockets

  (CAUTION: When handling lamp socket, keep bulb intact.)
- E. Dirty, improperly adjusted electrical equipment
- F. Loose, vibrating machine parts which might cause a short circuit
- G. Cracked insulation; bare or exposed wires

III. Major causes of electrical accidents

- A. Carelessness
- B. Misuse
- C. Improper wiring
- D. Lack of knowledge
- E. Water

  (CAUTION: Never handle electrical wires under wet conditions.)

IV. Ways to free someone receiving electrical shock (Transparency 2)

- A. 120-240 volts
  1. Locate line wire or source of electrical current and disconnect

     (CAUTION: Do not take hold of the person's body with your bare hand.)
  2. Decide immediately whether it would be easier to move person or move conductor

     (CAUTION: If conductor is to be moved, use some type of nonconductive material. If person's body is to be moved, use several thicknesses of paper or cloth as an insulator.)
  3. Grasp person's arm or leg with paper or cloth in hand and quickly pull the person free of the conductor
- B. Over 240 volts
  1. Assume a downed wire is hot and can kill you
  2. Protect the scene by posting a guard to keep passersby at least 200 feet away
  3. Call power supplier immediately and give exact location of the trouble

INFORMATION SHEET

V. First aid for electrical shock

  A. Call doctor or ambulance immediately

  B. Treat with mouth-to-mouth resuscitation

  (NOTE: If heart has stopped beating, heart massage is the only way to revive the victim.)

VI. Factors contributing to death from electrical shock

  A. Current (amperage) kills, not voltage

  B. Voltage is involved

  C. Less than 1/4 ampere will stop the heart

  (NOTE: Current flowing in a 25-watt lamp at 115 volts is enough to stop the heart of an average man.)

VII. Types of circuit protection devices (Transparencies 3 and 4)

  A. Fuses

    1. Blade

    2. Cartridge

    3. Plug

      a. Edison base

      b. Type S

    4. Accessory

    (NOTE: This fuse is mainly used in automotive and equipment circuits utilizing a battery as a primary source of power.)

  B. Circuit breakers

    1. Single pole

    2. Double pole

VIII. Signs that wiring is out-of-date

  A. Fuses blow

  B. Circuit breaker trips frequently

  C. Lights dim, blink, flicker

INFORMATION SHEET

D. Television picture wobbles

E. Appliances need longer heating time

F. Air conditioner fails to do its job

G. Motors are slow to come up to normal speed

H. Light bulbs burn out more quickly

I. Television picture shrinks

IX. Reasons for circuit failure

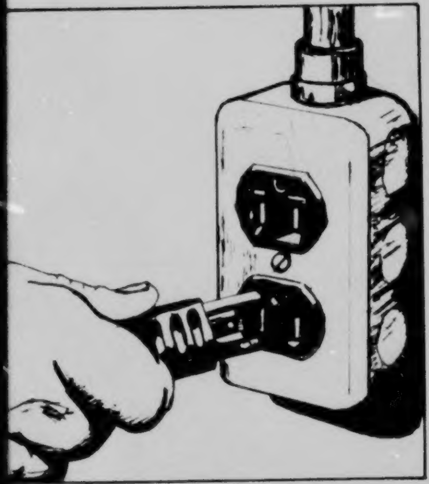
A. Circuit overloaded

B. Short circuit

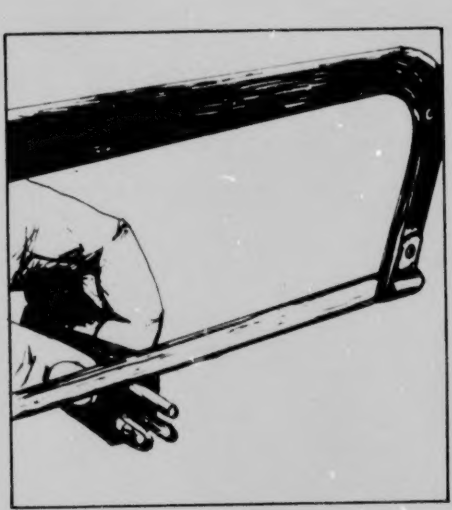
C. Wire broken

D. Equipment defective

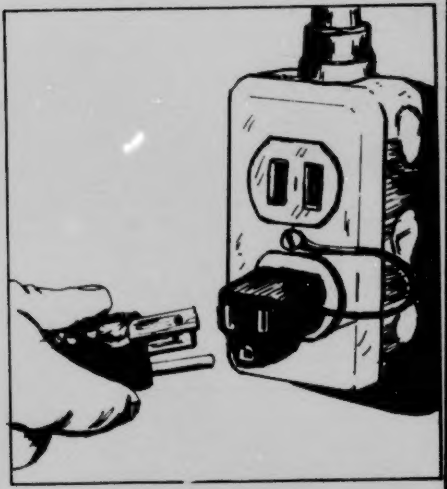
Safety Precautions



Modern homes have three-wire receptacles

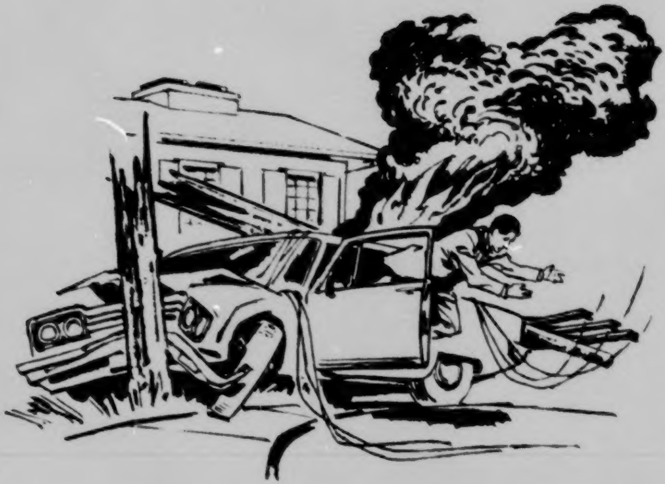


Never cut off the third prong

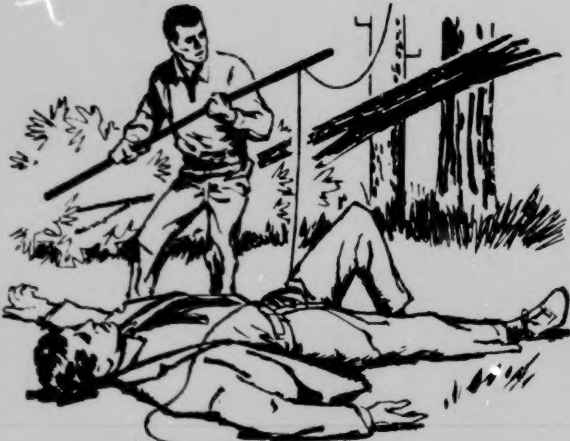


Use adaptor on old-type receptacle

Safety Precautions

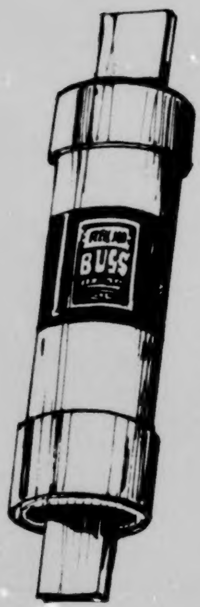


If a hot wire is in contact with a vehicle and the occupant must get out quickly, occupant should leap without touching the car again.

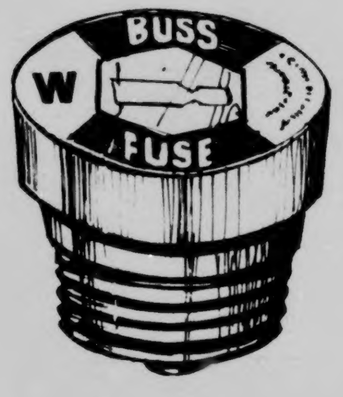


To remove a downed wire from a victim, use a nonconductor, such as a long dry wooden or plastic pole.

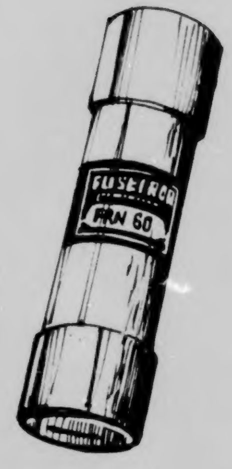
Circuit Protection Devices



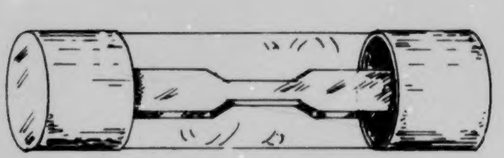
Blade Fuse



Edison Base Plug


FUSETRON
FRN 60

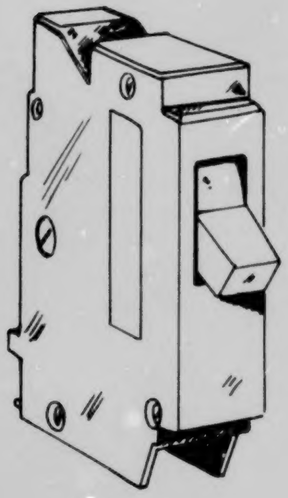
Cartridge Fuse



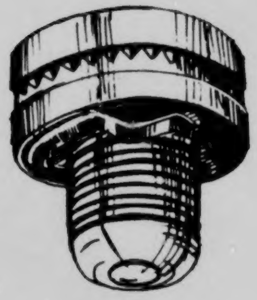
Accessory Fuse

Circuit Protection Devices

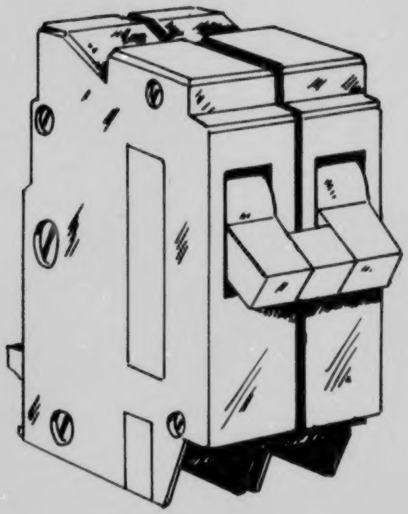
(Continued)



Single Pole Circuit Breaker



Type S Plug



Double Pole Circuit Breaker

ELECTRICAL SAFETY
UNIT I

ASSIGNMENT SHEET #1--SURVEY HOME FARM FOR SAFE AND UNSAFE ELECTRICAL CONDITIONS

Survey your home farm for safe and unsafe electrical conditions. While surveying the farm, complete the check sheet below. Check "yes" or "no" when the question applies to your local situation. When completed, return to class and turn in to instructor for discussion.

		YES	NO
1.	Are light cords hung over nails?	____	____
2.	Are cords showing signs of wear?	____	____
3.	Do switches work properly?	____	____
4.	Are lamps touching flammable material?	____	____
5.	Do lamps touch the wall?	____	____
6.	Will clothing touch the light globes?	____	____
7.	Is the lamp cord wrapped around bedstead or fastened to woodwork?	____	____
8.	Are the floor lamp cords worn?	____	____
9.	Can the floor lamp cords be stepped on?	____	____
10.	Is the television set well away from curtains?	____	____
11.	Is the television set well-ventilated in the back?	____	____
12.	Is the electric warming pad approved?	____	____
13.	Are cords found under the rug?	____	____
14.	Are there enough electrical outlets?	____	____
15.	Are wires strung through doors?	____	____
16.	Are any wall receptacles broken?	____	____
17.	Are all appliances approved by Underwriters' Laboratories?	____	____
18.	Is the refrigerator motor clean?	____	____
19.	Is the ventilating fan clean?	____	____
20.	Do fuses "blow" and breakers trip when appliances are connected?	____	____
21.	Is the pressing iron in good order?	____	____

ASSIGNMENT SHEET #1

		YES	NO
22.	Are signal lights working properly on appliances?	____	____
23.	Is washing machine in good order?	____	____
24.	Does the cord on the washing machine show signs of wear?	____	____
25.	Are the motors of dryer and washing machine free of lint and oil?	____	____
26.	Is the lighting circuit fuse or breaker larger than 15 amperes?	____	____
27.	Have fuses or circuit breakers been tampered with, such as pennies or other forms of dangerous substitutes used?	____	____
28.	Is the main switch clean and in good order?	____	____
29.	Is the panel switch door kept closed?	____	____
30.	Are extra fuses kept on hand?	____	____
31.	Are overhead wires to outbuildings properly supported and high enough for proper clearance of vehicles passing under such wires?	____	____
	(NOTE: The clearances should be ten feet above walkways and eighteen feet above driveways.)	____	____
32.	Are outbuildings properly grounded for lighting protection?	____	____

ELECTRICAL SAFETY
UNIT I

TEST

NAME____________________ SCORE____________________

1. Match terms associated with electrical safety to the correct definitions. Place the appropriate numbers in the blanks provided.

_____a. Double element time delay fuse designed to withstand momentary overloads

_____b. Unintended voltage leak to the ground

_____c. Safety device which breaks the flow of electrical current when a circuit becomes overloaded by burning out of a metal strip

_____d. Green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from hot to ground in a shorted piece of equipment

_____e. Handbook that sets minimum standards for wiring and materials

_____f. Completed path through which electricity flows

_____g. Tool used to check short circuits, hot lines, and voltages

_____h. Safety device which breaks the flow of electrical current when a circuit becomes overloaded by tripping a breaker switch

1. Fuse
2. National Electrical Code
3. Test lamp
4. Fusetron
5. Grounded wire
6. Circuit
7. Circuit breaker
8. Ground fault

2. Name five sources of electrical defects in equipment.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

3. Name two major causes of electrical accidents.

a. ______________________________

b. ______________________________

4. Discuss ways to free someone receiving electrical shock.

a. 120-240 volts

____

____

____

____

b. Over 240 volts

____

____

____

____

5. Discuss in a short paragraph first aid for a person who has just received electrical shock.

____

____

____

____

6. Discuss in a short paragraph factors contributing to death from electrical shock.

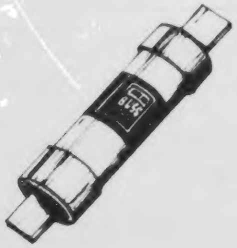
____

____

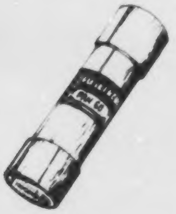
____

____

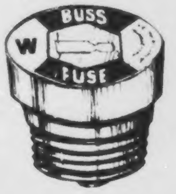
7. Identify the following types of circuit protection devices.



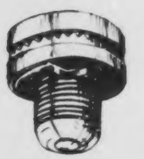
a. ________________



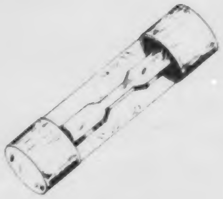
b. ________________



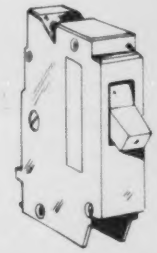
c. ________________



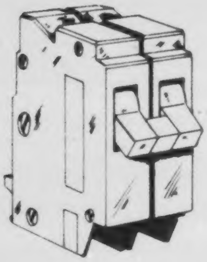
d. ________________



e. ________________



f. ________________



g. ________________

8. Name five signs that wiring is out-of-date.

a. ____

b. ____

c. ____

d. ____

e. ____

9. Name three reasons for circuit failure.

a. ____

b. ____

c. ____

10. Survey home farm for safe and unsafe electrical conditions.

(NOTE: If this activity has not been accomplished prior to test, ask the instructor when it should be completed.)

ELECTRICAL SAFETY
UNIT I

ANSWERS TO TEST

1. Match terms associated with electrical safety to the correct definitions. Place the appropriate numbers in the blanks provided.

4 a. Double element time delay fuse designed to withstand momentary overloads

8 b. Unintended voltage leak to the ground

1 c. Safety device which breaks the flow of electrical current when a circuit becomes overloaded by burning out of a metal strip

5 d. Green or bare wire which serves as the third wire on 115-volt appliances to provide an easy path for electricity to flow from hot to ground in a shorted piece of equipment

2 e. Handbook that sets minimum standards for wiring and materials

6 f. Completed path through which electricity flows

3 g. Tool used to check short circuits, hot lines, and voltages

7 h. Safety device which breaks the flow of electrical current when a circuit becomes overloaded by tripping a breaker switch

1. Fuse
2. National Electrical Code
3. Test lamp
4. Fusetron
5. Grounded wire
6. Circuit
7. Circuit breake
8. Ground fault

2. Name five sources of electrical defects in equipment.

(NOTE: Any five of the following are acceptable.)

a. Ground wire missing, broken, improperly connected, or not connected at all

b. Open conduits; switch boxes damaged or worn

c. Worn, wet, or oily insulation causing short circuits

d. Defective switches, receptacles, extension or lamp cords, and lamp sockets

   e. Dirty, improperly adjusted electrical equipment

   f. Loose, vibrating machine parts which might cause a short circuit

   g. Cracked insulation; bare or exposed wires

3. Name two major causes of electrical accidents.

   (NOTE: Any two of the following are acceptable.)

   a. Carelessness

   b. Misuse

   c. Improper wiring

   d. Lack of knowledge

   e. Water

4. Discuss ways to free someone receiving electrical shock.

   a. 120-240 volts

      1) Locate line wire or source of electrical current and disconnect

      2) Decide immediately whether it would be easier to move person or move conductor

      3) Grasp person's arm or leg with paper or cloth in hand and quickly pull person free of the conductor

   b. Over 240 volts

      1) Assume a downed wire is hot and can kill you

      2) Protect the scene by posting a guard to keep passersby at least 200 feet away

      3) Call power supplier immediately and give exact location of trouble

5. Discuss in a short paragraph first aid for a person who has just received electrical shock.

   a. Call doctor or ambulance immediately

   b. Treat with mouth-to-mouth resuscitation

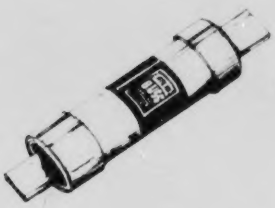
6. Discuss in a short paragraph factors contributing to death from electrical shock.

   a. Current (amperage) kills, not voltage

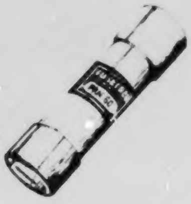
   b. Voltage is involved

   c. Less than 1/4 ampere will stop the heart

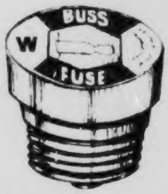
7. Identify the following types of circuit protection devices.



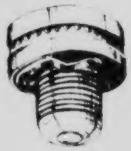
a. Blade fuse



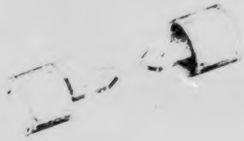
b. Cartridge fuse



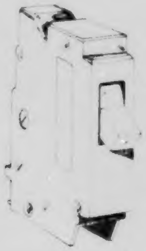
c. Edison base plug



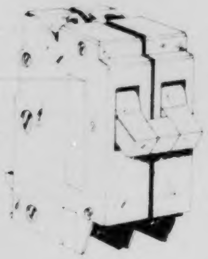
d. Type S plug



e. Accessory fuse



f. Single pole circuit breaker



g. Double pole circuit breaker

8. Name five signs that wiring is out-of-date.

(NOTE: Any five of the following are acceptable.)

a. Fuses blow

b. Circuit breaker trips frequently

c. Lights dim, blink, flicker

d. Television picture wobbles

e. Appliances need longer heating time

f. Air conditioner fails to do its job

g. Motors are slow to come up to normal speed

h. Light bulbs burn out more quickly

i. Television picture shrinks

9. Name three reasons for circuit failure.

(NOTE: Any three of the following are acceptable.)

a. Circuit overloaded

b. Short circuit

c. Wire broken

d. Equipment defective

10. Survey home farm for safe and unsafe electrical conditions.

(NOTE: The performance activity should be evaluated to the satisfaction of the instructor.)

FUNDAMENTALS OF ELECTRICITY
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish between a 115-volt and a 230-volt circuit. The student should be able to calculate the cost of operating electrical equipment and solve problems related to voltage, amperage, resistances, and wattages. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with fundamentals of electricity to the correct definitions.
2. Name benefits of using electricity.
3. Discuss the electron theory.
4. Name the sources of farm electricity.
5. Match the means of transporting electricity to correct descriptions.
6. Distinguish between 115-volt service and 230-volt service.
7. Name the types of power suppliers.
8. Match letter designations used in Ohm's law to the correct terms.
9. State Ohm's law as related to electricity.
10. Calculate problems using Ohm's law as related to power.
11. Name the types of electrical rates.
12. Name the types of kilowatt-hour electric meters.
13. Calculate the cost of operating electrical equipment.
14. Solve problems to determine voltage.
15. Solve problems to determine amperage.
16. Solve problems to determine resistances and wattages.

17. Demonstrate the ability to:
    a. Use a voltmeter.
    b. Use an ohmmeter.
    c. Use an ammeter.
    d. Use a watt meter.

FUNDAMENTALS OF ELECTRICITY
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

- A. Provide student with objective sheet.
- B. Provide student with information, assignment, and job sheets.
- C. Make transparencies.
- D. Discuss unit and specific objectives.
- E. Discuss information and assignment sheets and show film.
- F. Demonstrate procedures outlined in job sheets.
- G. Give test.

II. Unit references:

- A. Brown, Robert H. *Farm Electrification.* New York: McGraw-Hill Book Company, Inc.
- B. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc.
- C. *Farm Electricity.* State of Tennessee, Department of Education, Division of Vocational Education.
- D. *Basic Electricity and Practical Wiring Lessons.* University Park: Pennsylvania State University, College of Agriculture, Department of Agricultural Education.
- E. Wantiez, Gary W. *Air Conditioning and Refrigeration: Book Two.* Stillwater: Mid-America Vocational Curriculum Consortium, 1977.
- F. Whirlpool Tech-Care Home Products Service. *Basic Electricity for Appliances.* 2nd ed. Indianapolis: Howard W. Sams and Co., 1975.
- G. Carrier Air Conditioning Company. *Applied Electricity: Air Conditioning (Electric Meters).* Carrier Corporation, 1965.

III. Film--"Electricity for Beginners." Available from Coronet Films, 65 East South Water Street, Chicago, Illinois 60601.

(NOTE: Oklahoma teachers may order the film from the Curriculum and Instructional Materials Center, 1515 West Sixth, Stillwater, Oklahoma 74074.)

FUNDAMENTALS OF ELECTRICITY
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Electricity--Source of energy that can be easily converted into light, heat, or power

B. Ampere (amp)--Unit of measure of the rate of flow of electricity through a wire

C. Volt--Unit of measure of electrical pressure

D. Watt--Unit of measure used in determining the rate of energy supplied

E. Watt-hour--One watt for one hour

F. Kilowatt (kW)--1000 watts

G. Kilowatt-hour (kW-h)--Reference indicating the use of 1,000 watts of electricity for one hour

H. Horsepower (hp)--Unit of mechanical power which is equal to 746 watts of electrical power

(NOTE: Due to operational inefficiency and bearing drag, this wattage figure cannot be used to determine a motor's horsepower rating.)

I. Direct current (DC)--Current flows in one direction at a continuous rate

J. Alternating current (AC)--Current reverses at regular intervals

K. Circuit--Complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source

L. Switch--Device used to open or close circuit

M. Fuse--Safety device which opens the circuit when current becomes too great

(NOTE: A fuse must be replaced when open.)

N. Circuit breaker--Safety device which opens the circuit by tripping a switch rather than burning

(NOTE: A circuit breaker can be reset after time is allowed for cooling.)

O. Conductors--Wires which carry the electricity; wires through which electricity flows

INFORMATION SHEET

P. Insulation--Nonconductive protective covering over wires to prevent completing a circuit except where desired

Q. Hot wires--Current-carrying conductors with electrical pressure on them (usually black or red); connected to fuse or circuit breaker at distribution panel, subpanel, or fusable disconnect

R. Neutral wires--Intentionally grounded current-carrying conductors with no pressure on them (usually white); connected to neutral base at the distribution panel

S. Grounding--Connection of the neutral part of the electrical system to the earth to reduce the possibility of damage from lightning; connection of the housings of electrical equipment to the earth to minimize the danger of electrical shock

T. Short circuit--Improper connection between hot and neutral wires or between hot wires

U. Voltage drop--Loss in electrical pressure from its source to its point of use

(NOTE: This may be caused by size of wire, type of wire, and distance.)

V. U.L. (Underwriter's Laboratories)--Nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet predetermined standards for safety and quality

W. Service transformer--Alternating current device used to change voltage from primary to secondary

Examples: From 6,900 volts primary to 115 volts or 230 volts secondary
From 115 volts primary to 230 volts secondary

X. Single phase--Type of electrical service available to most farms requiring one transformer between power supplier and customer

Y. Three phase--Three conductors carrying voltage in one circuit; more efficient

Z. Meter--Instrument which records the amount of electrical energy used (kilowatt hours)

AA. Resistance--Property of a substance that opposes the flow of current

II. Benefits of using electricity

A. Light

B. Power

INFORMATION SHEET

- C. Heat
- D. Cooling
- E. Communications
- F. Special controls

III. Electron theory

- A. Electron--Particle having a negative charge
- B. Proton--Particle having a positive charge
- C. Negative electron--Particle which moves freely

  (NOTE: Negative electrons circulate about positive protons which form the nucleus of the atoms.)

IV. Sources of farm electricity

- A. Individual plant
- B. Central station and distribution lines

  (NOTE: This power is generally purchased.)

V. Means of transporting electricity (Transparency 1)

- A. Transmission line--Line that extends from generating station to substation or from substation to substation

  (NOTE: Transmission lines generally carry 30,000 to 130,000 volts.)

  Example: Steel towers or double poles

- B. Distribution line--Line beginning at a substation and extending out over the countryside, usually ranging from three to fifteen miles

  (NOTE: Distribution lines generally carry 7,200 to 13,000 volts.)

- C. Service drop line--Line that runs from a distribution line to the meter pole
- D. Feeder line--Line that runs from the meter pole to the house

VI. Differences between 115-volt service and 230-volt service

- A. 115-volt service--Two lines running to the house
- B. 230-volt service--Three lines running to the house

INFORMATION SHEET

VII. Types of power suppliers

  A. REA cooperatives

  B. Public or private companies

VIII. Letter designations used in Ohm's law (Transparency 2)

  A. Voltage = E (electromotive force measured in volts)

  B. Current = I (intensity in amps)

  C. Resistance = R (resistance in ohms)

IX. Ohm's law–Current (intensity in amps) in an electric circuit equals the pressure (volts) divided by the resistance (amperes) (Transparency 2)

X. Ohm's law as related to power (Transparency 3)

  A. P = I x E (Watts = Amps x Volts)

  Example: P = I x E

  Watts = Amps x Volts

  Watts = 0.5 amps x 24 volts

  12 watts = 0.5 amp x 24 volts

  B. I = P ÷ E (Amps = Watts ÷ Volts)

  Example: I = P ÷ E

  Amps = Watts ÷ Volts

  Amps = 690 watts ÷ 115 volts

  6 amps = 690 watts ÷ 115 volts

  C. E = P ÷ I (Volts = Watts ÷ Amps)

  Example: E = P ÷ I

  Volts = Watts ÷ Amps

  Volts = 500 watts ÷ 4 amps

  125 volts = 500 watts ÷ 4 amps

INFORMATION SHEET

XI. Types of electrical rates

  A. Residential

  B. Commercial

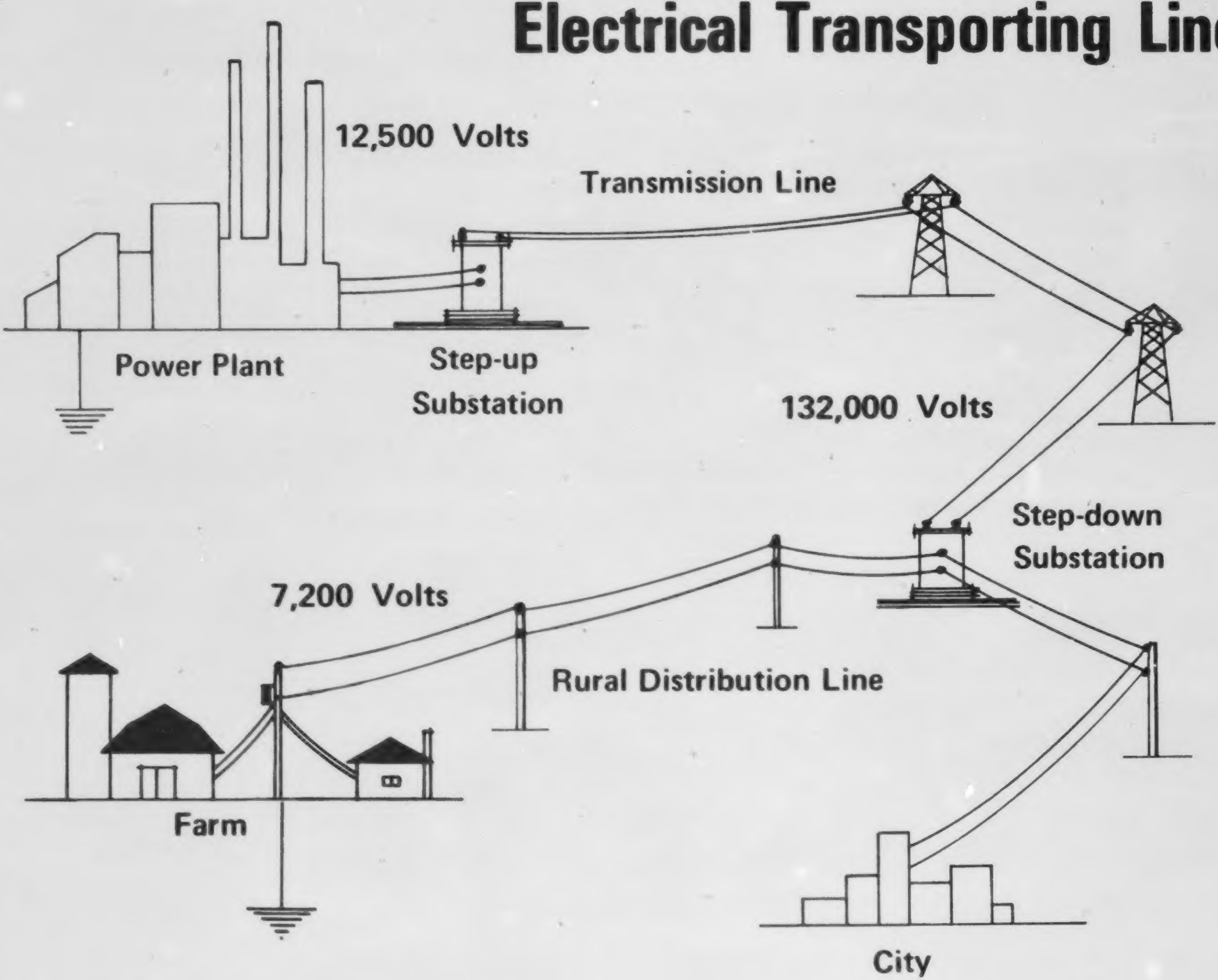
  C. Special

XII. Types of kilowatt-hour electric meters (Transparencies 4 and 5)

  A. Pointer-dial electric meter

  B. Cyclometer electric meter

Electrical Transporting Lines


12,500 Volts
Transmission Line
Power Plant
Step-up
Substation
132,000 Volts
Step-down
Substation
7,200 Volts
Rural Distribution Line
Farm
City

OHM'S Law

$I = \frac{E}{R}$

$$\text{Amperes} = \frac{\text{Volts}}{\text{OHMS}}$$

$E = IR$

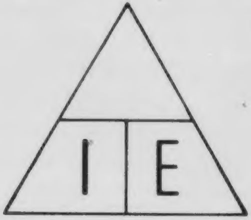
$$\text{Volts} = \text{Amperes} \times \text{OHMS}$$

$R = \frac{E}{I}$

$$\text{OHMS} = \frac{\text{Volts}}{\text{Amperes}}$$

OHM'S Law Formulas as Related to Power

$P =$

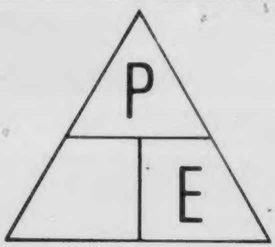


or

$P = I \times E$ or

Watts = Amps × Volts

$I =$

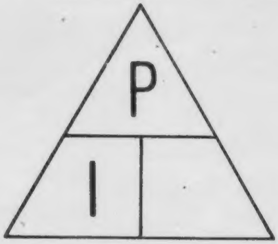


or

$I = P/E$ or

Amps = Watts ÷ Volts

$E =$

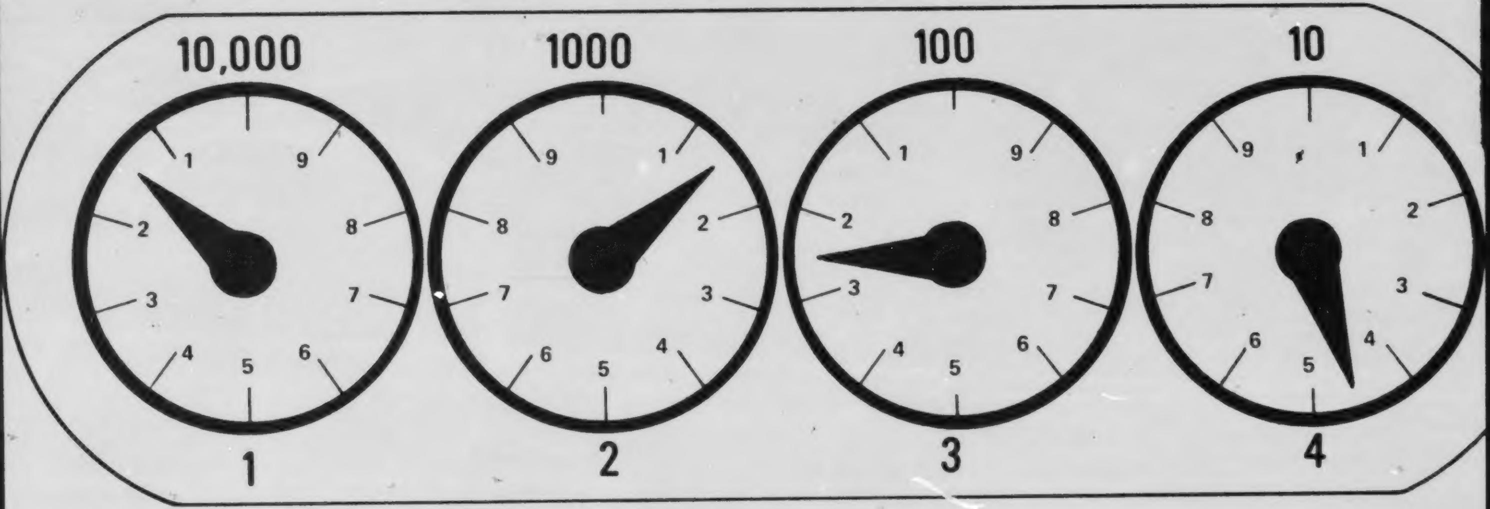


or

$E = P/I$ or

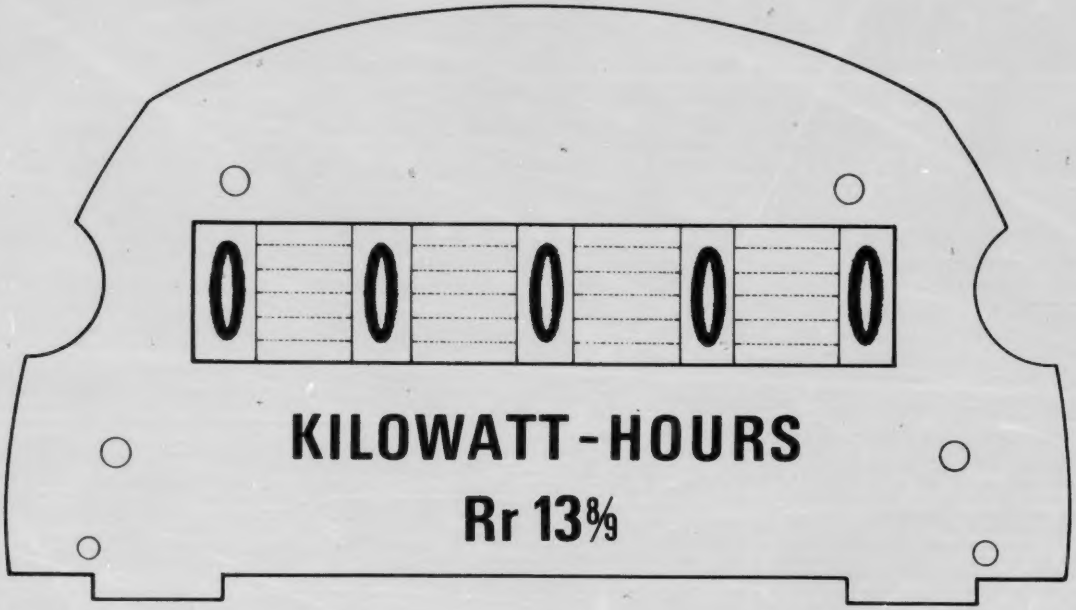
Volts = Watts ÷ Amps

Pointer-Dial Electric Meter



Read the last figure passed by the hand. When the hand seems to be on the number, the dial to the right should be consulted to see whether or not the number has been passed. Dial 4 shows the number of tenths. Dial 3 shows the number of one-hundredths. Dial 2 shows the number of one-thousandths.

Cyclometer Electric Meter


0 0 0 0 0
KILOWATT-HOURS
Rr 13 8/9

FUNDAMENTALS OF ELECTRICITY
UNIT II

ASSIGNMENT SHEET #1--CALCULATE COST OF OPERATING ELECTRICAL EQUIPMENT

Work each of the problems listed below by using the information provided. All problems should be worked using the average cost of 2¢ per kW·h for electricity. Be sure to show your work.

Watts x Hours of Operation = Watt-hours

Kilowatt-hours (kW·h) $= \dfrac{\text{Watts x Hours}}{1000}$

Multiply 1,200 by hp rating if motor is smaller than one-half hp

Multiply 1,000 by hp rating if motor is one-half hp or greater

Example: 1/4 hp motor x 1,200 = 300 watts

300 watts x 2 hours of operation = 600 watt-hours

$\dfrac{600}{1000} = 0.6$ kW·h

0.6 x 2¢ = 1.2¢

1. How much would it cost to operate a 1/4 hp motor for 12 hours?

2. How much would it cost to operate a 2 hp motor for 10 hours?

3. How much would it cost to operate a 100 watt light bulb for a period of 12 hours?

ASSIGNMENT SHEET #1

4. An electric refrigerator requires 150 watts of electric power. It operates an average of four hours each day. How many kilowatt-hours would be used in 30 days, and how much would it cost for operation?

5. What would be the cost of operating a heat lamp that pulls 200 watts for 5 hours?

FUNDAMENTALS OF ELECTRICITY
UNIT II

ASSIGNMENT SHEET #2--SOLVE PROBLEMS TO DETERMINE VOLTAGE

Apply the appropriate formula from Ohm's law to find the voltage.

Example 1: 2 amps, 60 ohms = _____ volts

Amperes	x	Ohms	=	Volts
2	x	60	=	120

Example 2: 2 amps, 240 watts = _____ volts

Watts	÷	Amperes	=	Volts
240	÷	2	=	120

PROBLEMS

	Amps	Ohms		Volts
1.	20	6	=	_____
2.	4	60	=	_____
3.	9.6	2.5	=	_____
4.	5	2.4	=	_____

	Amps	Watts		
5.	6	1380	=	_____
6.	6.5	715	=	_____
7.	2.5	1000	=	_____
8.	5	600	=	_____
9.	7	805	=	_____
10.	4	500	=	_____

FUNDAMENTALS OF ELECTRICITY
UNIT II

ASSIGNMENT SHEET #3--SOLVE PROBLEMS TO DETERMINE AMPERAGE

Apply the appropriate formula to find the amperage.

Example 1: 120 volts, 40 ohms = ___________ amps

Volts ÷ Ohms = Amperes
120 ÷ 40 = 30

Example 2: 120 watts, 120 volts = ___________ amps

Watts ÷ Volts = Amps
120 ÷ 120 = 1

PROBLEMS

	Volts	Ohms		Amps
1.	230	12	=	
2.	110	11	=	
3.	440	20	=	
4.	120	40	=	
5.	24	3	=	
	Watts	**Volts**		**Amps**
6.	6,000	120	=	
7.	2,640	240	=	
8.	8,800	440	=	
9.	690	115	=	
10.	2,760	230	=	

FUNDAMENTALS OF ELECTRICITY
UNIT II

ASSIGNMENT SHEET #4--SOLVE PROBLEMS TO DETERMINE RESISTANCES AND WATTAGES

Apply the appropriate formula to solve the problems below.

Example 1: 440 volts, 10 amps = ____________ ohms

Volts	÷	Amps	=	Ohms
440	÷	10	=	44

Example 2: 115 volts, 12 amps = ____________ watts

Volts	x	Amps	=	Watts
115	x	12	=	1380

PROBLEMS

	Volts	Amps	Ohms
1.	240	4	
2.	24	9.6	
3.	12	5	
4.	230	17.5	
5.	24	8	

	Volts	Amps	Watts
6.	240	11	
7.	115	6	
8.	440	20	
9.	230	50	
10.	24	0.5	

FUNDAMENTALS OF ELECTRICITY
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 7.2¢
2. 40¢
3. 2.4¢
4. 18 kW·h, 36¢
5. 2¢

Assignment Sheet #2

1. 120
2. 240
3. 24
4. 12
5. 230
6. 110
7. 40
8. 120
9. 115
10. 125

Assignment Sheet #3

1. 19.2
2. 10
3. 22
4. 3
5. 8
6. 50
7. 11
8. 20
9. 6
10. 12

Assignment Sheet #4

1. 60
2. 2.5
3. 2.4
4. 13.1
5. 3
6. 2640
7. 690
8. 8800
9. 11500
10. 12

FUNDAMENTALS OF ELECTRICITY
UNIT II

JOB SHEET #1--USE A VOLTMETER

I. Tools and materials

A. Voltmeter

B. Safety glasses

C. 120 VAC wall outlet

D. 240 VAC wall outlet

E. 240 VAC one phase disconnect

F. Three phase disconnect

(NOTE: All of these materials should be connected to the proper voltage.)

II. Procedure

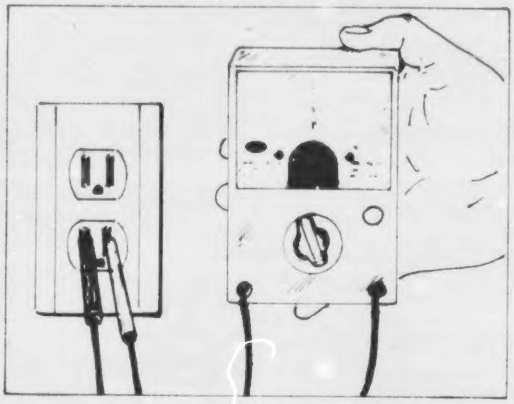
(NOTE: Use this only if instruction has been provided.)

A. Put on safety glasses

B. Select highest A.C. scale

C. Check across a 120 VAC wall outlet (Figure 1)

FIGURE 1

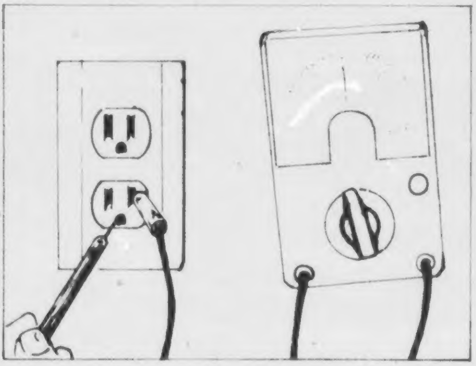


JOB SHEET #1

D. Select meter scale that will allow for the most accurate reading

E. Check from each side to ground (Figure 2)

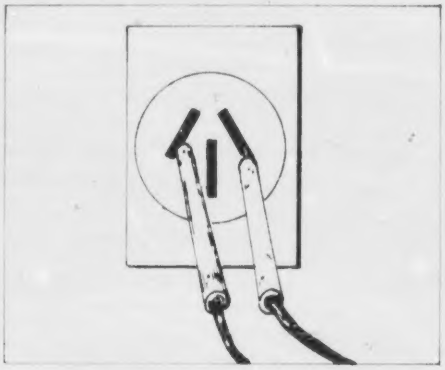
FIGURE 2



F. Switch to highest A.C. scale

G. Check across a 240 VAC wall outlet (Figure 3)

FIGURE 3

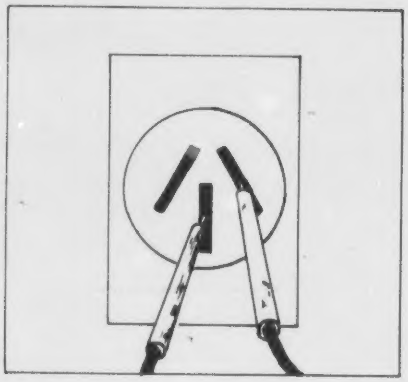


H. Select meter scale that will allow for the most accurate reading

JOB SHEET #1

I. Check from each side to ground (Figure 4)

FIGURE 4



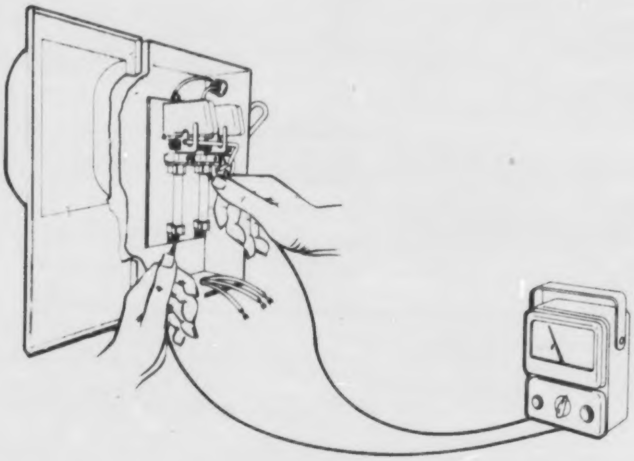
J. Switch to highest A.C. scale

K. Check line side of disconnect

L. Select meter scale that will allow for the most accurate reading

M. Check load side of disconnect (Figure 5)

FIGURE 5



N. Repeat steps J through M and check a three phase disconnect

O. Put away voltmeter

(NOTE: Have instructor observe your work.)

FUNDAMENTALS OF ELECTRICITY
UNIT II

JOB SHEET #2--USE AN OHMMETER

I. Tools and materials

  A. Ohmmeter

  B. Safety glasses

  C. Bleed resistor, 2 watt 20K ohm

  D. Hermetic compressor, single phase

  E. Plug type fuse

  F. Cartridge type fuse

II. Procedure

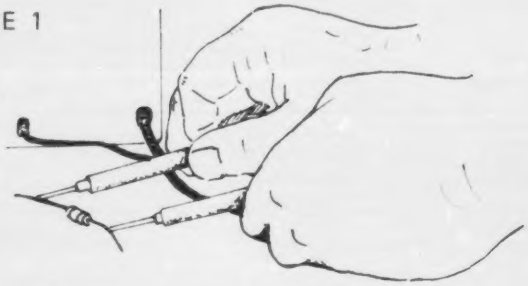
  A. Put on safety glasses

  B. Select highest ohm scale

  C. Zero meter

  D. Touch meter probes to resistor leads (Figure 1)

FIGURE 1



JOB SHEET #2

E. Read the resistance on the ohmmeter scale

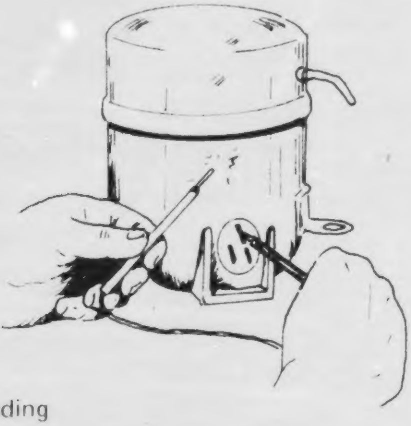
(NOTE: Have instructor check your reading.)

F. Select R x 1 scale

G. Rezero meter

H. Touch meter leads to two compressor terminals (Figure 2)

FIGURE 2



I. Record resistance reading

J. Move one probe to remaining terminal

K. Record resistance reading

L. Take the third resistance reading

M. Record the third resistance reading

N. Identify the start, run, and common terminals

(NOTE: Have the instructor check your work.)

O. Check plug fuse

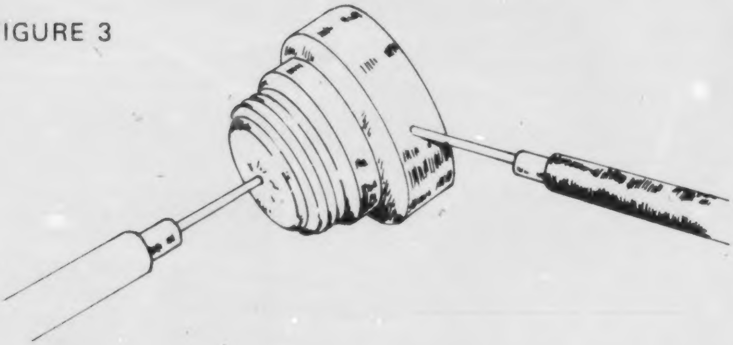
P. Touch one ohmmeter probe to outer metallic portion

JOB SHEET #2

Q. Touch the ohmmeter probe to the button on the bottom (Figure 3)

(NOTE: Never check a fuse with an ohmmeter in a complete circuit.)

FIGURE 3



(NOTE: If the needle swings to zero, the fuse is good. If the needle stays at infinity, the fuse is not good.)

R. Touch the ohmmeter leads to each end of a cartridge type fuse

(NOTE: A good or bad cartridge fuse will be indicated in the same manner as the plug fuse was. Have instructor cneck.)

S. Turn ohmmeter to the Off position or to the highest A.C. voltage range

T. Put away tools and materials

FUNDAMENTALS OF ELECTRICITY
UNIT II

JOB SHEET #3--USE AN AMMETER

I. Tools and materials

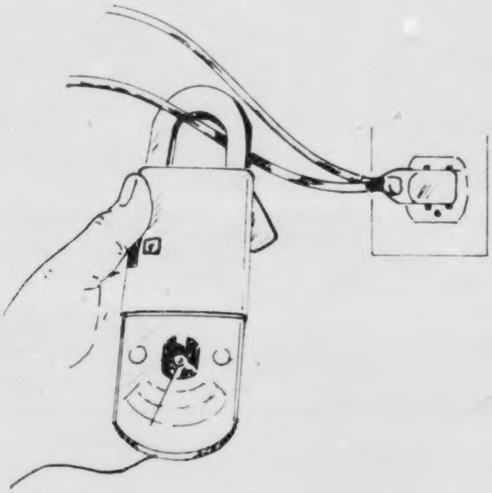
- A. Clamp-on ammeter with energizer
- B. Safety glasses
- C. Electric motor, 1/3 hp or 1/4 hp

II. Procedure

- A. Put on safety glasses
- B. Select highest amperage scale
- C. Clamp ammeter around one conductor of the line cord (Figure 1)

  (NOTE: Placing the ammeter around two conductors of single phase power will cancel out the amperage reading.)

FIGURE 1



- D. Start electric motor
- E. Record starting amperage

  (NOTE: Starting amperage will only last an instant, usually two to five seconds.)

JOB SHEET #3

F. Allow the motor to run

G. Record running amperage

H. Check F.L.A. on nameplate

I. Compare the nameplate amperage to the ammeter reading

(NOTE: Have instructor check.)

J. Put away meter and materials

FUNDAMENTALS OF ELECTRICITY
UNIT II

JOB SHEET #4--USE A WATT METER

I. Tools and materials

   A. Watt meter

   B. Safety glasses

   C. Current-consuming device

II. Procedure

   A. Put on safety glasses

   B. Read instructions supplied with watt meter if available

   C. Select the proper voltage

   D. Connect the watt meter to line voltage

   E. Select the highest wattage scale

   F. Connect current-consuming device

   (NOTE: Have instructor check.)

   G. Start the current-consuming device

   H. Record starting wattage

   I. Allow unit to run a few minutes while the wattage levels out

   J. Select wattage scale that will allow for the easiest reading

   K. Record running wattage

   L. Obtain full load amperage from unit's nameplate

   M. Divide the voltage into the wattage to obtain the F.L.A.

   (NOTE: Remember Watt's law is primarily for D.C. power. However, for our purposes the power factor is generally close enough to one that it can be used for A.C. power.)

JOB SHEET #4

N. Use an ammeter to check your answer

(NOTE: The use of the ammeter is covered in Job Sheet #3 of this unit. Have instructor check.)

O. Put away meter and materials

FUNDAMENTALS OF ELECTRICITY
UNIT II

TEST

NAME ______________________________ SCORE ____________________

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

_____a. Unit of measure of the rate of flow of electricity through a wire

_____b. One watt for one hour

_____c. Reference indicating the use of 1,000 watts of electricity for one hour

_____d. Unit of measure of electrical pressure

_____e. Source of energy that can be easily converted into light, heat, or power

_____f. Unit of measure used in determining the rate of energy supplied

_____g. Unit of mechanical power which is equal to 746 watts of electrical power

_____h. Safety device which opens the circuit by tripping a switch rather than burning

_____i. Current flows in one direction at a continuous rate

_____j. Current reverses at regular intervals

_____k. Safety device which opens the circuit when current becomes too great

_____l. Complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source

1. Electricity
2. Ampere (amp)
3. Volt
4. Watt
5. Watt-hour
6. Kilowatt hour (kW·h)
7. Horsepower (hp)
8. Direct current (DC)
9. Alternating current (AC)
10. Circuit
11. Circuit breaker
12. Fuse

______m. Device used to open or close circuit

______n. Loss in electrical pressure from its source to its point of use

______o. Property of a substance that opposes the flow of current

______p. Nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet predetermined standards for safety and quality

______q. Improper connection between hot and neutral wires or between hot wires

______r. Alternating current device used to change voltage from primary to secondary

______s. Connection of the neutral part of the electrical system to the earth to reduce the possibility of damage from lightning; connection of the housings of electrical equipment to the earth to minimize the danger of electrical shock

______t. Wires which carry the electricity; wires through which electricity flows

______u. Type of electrical service available to most farms requiring one transformer between power supplier and customer

______v. Intentionally grounded current-carrying conductors with no pressure on them (usually white); connected to neutral base at the distribution panel

______w. Three conductors carrying voltage in one circuit; more efficient

______x. Nonconductive protective covering over wires to prevent completing a circuit except where desired

13. Switch
14. Conductors
15. Resistance
16. Three phase
17. Neutral wires
18. Grounding
19. Short circuit
20. Voltage drop
21. U. L. (Underwriter's Laboratories)
22. Service transformer
23. Single phase
24. Insulation
25. Hot wires
26. Meter
27. Kilowatt (kW)

(NOTE: Definitions are continued on the next page.)

______y. Instrument which records the amount of electrical energy used (kilowatt-hours)

______z. Current-carrying conductors with electrical pressure on them (usually black or red); connected to fuse or circuit breaker at distribution panel, subpanel, or fusable disconnect

____aa. 1000 watts

2. Name three benefits of using electricity.

a. ____

b. ____

c. ____

3. Discuss the electron theory.

____

____

____

4. Name the sources of farm electricity.

a. ____

b. ____

5. Match the means of transporting electricity to the correct descriptions. Place the appropriate numbers in the blanks provided.

______a. Line that extends from generating station to substation or from substation to substation

______b. Line beginning at a substation and extending out over the countryside, usually ranging from three to fifteen miles

______c. Line that runs from a distribution line to the meter pole

______d. Line that runs from the meter pole to the house

1. Distribution line

2. Transmission line

3. Feeder line

4. Service drop line

6. Distinguish between 115-volt service and 230-volt service by placing an "X" in the blank representing 230-volt service.

   ______a. Two lines running to the house

   ______b. Three lines running to the house

7. Name the types of power suppliers.

   a. ____

   b. ____

8. Match letter designations used in Ohm's law to the correct terms.

______a. Current	1.	I
______b. Voltage	2.	R
______c. Resistance	3.	E

9. State Ohm's law as related to electricity.

   ____

   ____

10. Calculate problems using Ohm's law as related to power.

    a. 1,250 watts 6 amps = __________volts

    b. 400 watts 120 volts = __________amps

    c. 120 volts 4 amps = __________watts

11. Name the types of electrical rates.

    a. ____

    b. ____

    c. ____

12. Name the types of kilowatt-hour electric meters.

    a. ____

    b. ____

13. Calculate the cost of operating electrical equipment.

14. Solve problems to determine voltage.

15. Solve problems to determine amperage.

16. Solve problems to determine resistances and wattages.

17. Demonstrate the ability to:
    a. Use a voltmeter.
    b. Use an ohmmeter.
    c. Use an ammeter.
    d. Use a watt meter.

(NOTE: If activities 13-17 have not been accomplished prior to the test, ask your instructor when they should be completed.)

FUNDAMENTALS OF ELECTRICITY
UNIT II

ANSWERS TO TEST

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

2 a. Unit of measure of the rate of flow of electricity through a wire

5 b. One watt for one hour

6 c. Reference indicating the use of 1,000 watts of electricity for one hour

3 d. Unit of measure of electrical pressure

1 e. Source of energy that can be easily converted into light, heat, or power

4 f. Unit of measure used in determining the rate of energy supplied

7 g. Unit of mechanical power which is equal to 746 watts of electrical power

11 h. Safety device which opens the circuit by tripping a switch rather than burning

8 i. Current flows in one direction at a continuous rate

9 j. Current reverses at regular intervals

12 k. Safety device which opens the circuit when current becomes too great

10 l. Complete path through which electricity flows, such as from the power source to a lamp, through the lamp, and back to the power source

13 m. Device used to open or close circuit

20 n. Loss in electrical pressure from its source to its point of use

1. Electricity
2. Ampere (amp)
3. Volt
4. Watt
5. Watt-hour
6. Kilowatt-hour (kW·h)
7. Horsepower (hp)
8. Direct current (DC)
9. Alternating current (AC)
10. Circuit
11. Circuit breaker
12. Fuse

15 o. Property of a substance that opposes the flow of current

21 p. Nationally accepted organization which tests all types of wiring materials and devices to make certain that they meet predetermined standards for safety and quality

19 q. Improper connection between hot and neutral wires or between hot wires

22 r. Alternating current device used to change voltage from primary to secondary

18 s. Connection of the neutral part of the electrical system to the earth to reduce the possibility of damage from lightning; connection of the housings of electrical equipment to the earth to minimize the danger of electrical shock

14 t. Wires which carry the electricity; wires through which electricity flows

23 u. Type of electrical service available to most farms requiring one transformer between power supplier and customer

17 v. Intentionally grounded current-carrying conductors with no pressure on them (usually white); connected to neutral base at the distribution panel

16 w. Three conductors carrying voltage in one circuit; more efficient

24 x. Nonconductive protective covering over wires to prevent completing a circuit except where desired

26 y. Instrument which records the amount of electrical energy used (kilowatt-hours)

13. Switch
14. Conductors
15. Resistance
16. Three phase
17. Neutral wires
18. Grounding
19. Short circuit
20. Voltage drop
21. U. L. (Underwriter's Laboratories)
22. Service transformer
23. Single phase
24. Insulation
25. Hot wires
26. Meter
27. Kilowatt (kW)

(NOTE: Definitions are continued on the next page.)

25 z. Current-carrying conductors with electrical pressure on them (usually black or red); connected to fuse or circuit breaker at distribution panel, subpanel, or fusable disconnect

27 aa. 1000 watts

2. Name three benefits of using electricity.

(NOTE: Any three of the following are acceptable.)

a. Light

b. Power

c. Heat

d. Cooling

e. Communications

f. Special controls

3. Discuss electron theory.

a. Electron--Particle having a negative charge

b. Proton--Particle having a positive charge

c. Negative electron--Particle which moves freely

4. Name the sources of farm electricity.

a. Individual plant

b. Central station and distribution lines

5. Match the means of transporting electricity to the correct descriptions. Place the appropriate numbers in the blanks provided.

2 a. Line that extends from generating station to substation or from substation to substation

1 b. Line beginning at a substation and extending out over the countryside, usually ranging from three to fifteen miles

1. Distribution line

2. Transmission line

__4__ c. Line that runs from a distribution line to the meter pole

__3__ d. Line that runs from the meter pole to the house

3. Feeder line
4. Service drop line

6. Distinguish between 115-volt service and 230-volt service by placing an "X" in the blank representing 230-volt service.

_____ a. Two lines running to the house

__X__ b. Three lines running to the house

7. Name the types of power suppliers.

a. REA cooperatives

b. Public or private companies

8. Match letter designations used in Ohm's law to the correct terms on the left. Place the appropriate numbers in the blanks provided.

__1.__ a. Current

__3__ b. Voltage

__2__ c. Resistance

1. I
2. R
3. E

9. State Ohm's law as related to electricity.

Current (intensity in amps) in an electric circuit equals the pressure (volts) divided by the resistance (amperes)

10. Calculate problems using Ohm's law as related to power.

a. 1,250 watts ÷ 6 amps = 208.33 volts

b. 400 watts ÷ 120 volts = 3.33 amps

c. 120 volts x 4 amps = 480 watts

11. Name the types of electrical rates.

a. Residential

b. Commercial

c. Special

12. Name the types of kilowatt-hour electric meters.

a. Pointer-dial electric meter

b. Cyclometer electric meter

13. Calculate the cost of operating electrical equipment.

14. Solve problems to determine voltage.

15. Solve problems to determine amperage.

16. Solve problems to determine resistances and wattages.

17. Demonstrate the ability to:

    a. Use a voltmeter.

    b. Use an ohmmeter.

    c. Use an ammeter.

    d. Use a watt meter.

    (NOTE: Activities 13-17 should be evaluated to the satisfaction of the instructor.)

ELECTRICAL WIRING PRACTICES
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify electrical tools and devices. The student should be able to complete a chart on conductors, types, and uses and match electrical schematic symbols to their names. The student should be able to demonstrate the ability to wire receptacles and lighting outlets. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with electrical wiring to the correct definitions.
2. Identify tools used in electrical wiring.
3. Identify electrical devices.
4. Complete a chart on conductors, types, and uses.
5. Name factors affecting voltage drop.
6. Arrange in order the procedure to follow in wiring.
7. Match electrical schematic symbols to their names.
8. Distinguish between schematic diagrams and wiring diagrams.
9. Demonstrate the ability to:
    a. Wire a lighting outlet controlled by a single pole switch with a duplex receptacle.
    b. Wire three duplex receptacles using nonmetallic cable.
    c. Wire lighting outlet controlled by two three-way switches.
    d. Wire a range plug.

ELECTRICAL WIRING PRACTICES
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives with students.

   E. Discuss information sheet with students.

   F. Demonstrate procedures for completing job sheets.

   G. Give test.

II. Unit references:

   A. Brown, Robert H. *Farm Electrification*. New York: McGraw-Hill Book Company, Inc.

   B. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook*. Danville, Illinois: The Interstate Printers and Publishers, Inc.

   C. *Farm Electricity*. State of Tennessee, Department of Education, Division of Vocational Education.

   D. *Basic Electricity and Practical Wiring Lessons*. University Park: Pennsylvania State University, College of Agriculture, Department of Agricultural Education.

ELECTRICAL WIRING PRACTICES
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Conductors--Wires, cords, or cables which carry the electricity or through which electricity flows

B. Cable--Two or more conductors grouped together inside an overall covering

C. Cord--Two or more stranded conductors grouped together in a flexible covering

D. Wire--Single conductor which carries electricity

(NOTE: This is usually a solid wire.)

E. Terminal--Device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections

F. Schematic diagram--Line-type illustration using standardized symbols to represent an electrical circuit

G. Wiring diagram--Plan which shows the electric circuit with items arranged and appearing so the job of connecting will be simplified

H. Junction box--Outlet box with a blank cover used to contain splices of a circuit

I. Outlet box--Box-like device which is used to bring the wires to the location where a switch or outlet is installed; handy box

J. Receptacle outlet--Device which contains the splices when a circuit is tapped for an appliance or a light

K. Conduit--Thin-walled steel pipe used to protect electrical wires

L. Single pole toggle switch--Switch used to break the current in a single place

M. Three-way switch--Switch used to control lights and motors from two different places

N. Four-way switch--Switch used to control lights and motors from three or more different places

O. Wire gauge--Tool used to measure wire diameter

P. Wire size--Measure of wire diameter

Q. Polarized--Having slots or contact blades paired so as not to allow for a different contact arrangement

INFORMATION SHEET

II. Electrical wiring tools (Transparencies 1 and 2)

   A. Needle nose pliers

   B. Lineman's pliers

   C. Diagonal pliers

   D. Wire cutter or stripper

   E. Standard screwdriver

   F. Phillips screwdriver

   G. Pocket knife

   H. Hammer

   I. Wood chisel

   J. Electric drill

   K. Tape or rule

   L. Keyhole saw

   M. Hacksaw

   N. Test light

   O. Amp-volt meter

   P. Vise-grip pliers

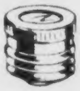
   Q. Fish tape and reel

   R. Conduit bender

III. Electrical devices

   A. Edison base plug fuse

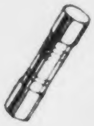
   (NOTE: These can be either single element or dual element time delay fuses.)



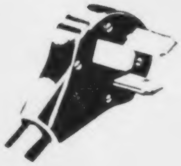
INFORMATION SHEET

B. Cartridge fuse

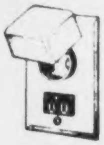
(NOTE: These can be single element, dual element time delay, or of special design classification for specific installations.)



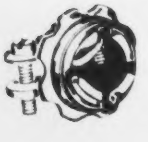
C. Heavy duty plug



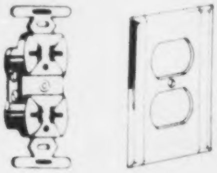
D. Fuse box cover with grounded outlet for fractional horsepower motor protection



E. Connector



F. Duplex grounding receptacle and cover

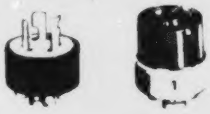


INFORMATION SHEET

G. Surface mount range receptacle

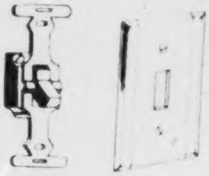
H. Surface mount duplex grounding receptacle

I. Three wire twist lock connector and plug



J. Toggle switch and cover

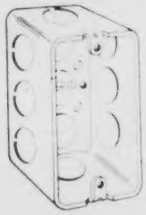
(NOTE: This can be single pole, three-way, or double pole.)



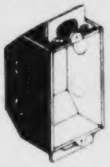
K. Crow foot plug and connector

INFORMATION SHEET

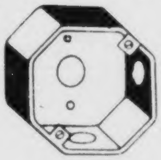
L. Handy box



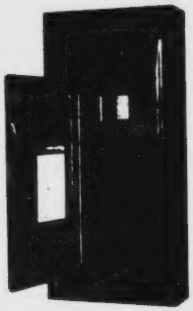
M. Beveled cornered wall box with plaster ears



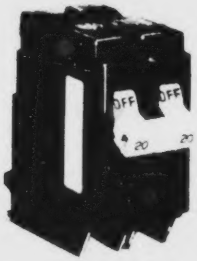
N. Octagon box



O. Distribution panel

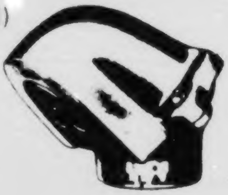


P. 240-volt breaker

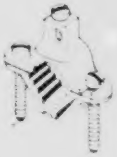


INFORMATION SHEET

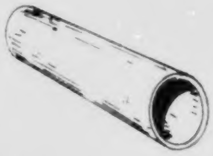
Q. Service entrance cap (weather head)



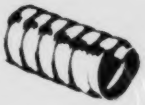
R. Ground clamp



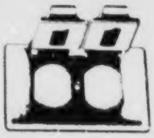
S. Rigid steel conduit



T. Flexible steel conduit



U. Weatherproof wallplate



INFORMATION SHEET

IV. Conductors, types, and uses

ITEM	TYPE	USE
Wire	A	Heating appliances within apparatus, dry locations
Wire	TW	Inside of conduit, dry and wet locations
Wire	USE	Trench, underground
Wire	TW (Low Voltage)	Low voltage alarm or relay controls
Cord	HPN	Heater cord
Cord	S	Hard usage, welders, large motors
Cord	HC	Iron, heaters
Cord	SJ	Portable tools
Cord	SV	Vacuum cleaners, mixers
Cable	Triplex	Outside, overhead service
Cable	UF	Underground, feeder and branch circuits
Cable	NM	Inside, dry locations

(NOTE: Wire, cord, and cable come in various sizes according to specific application. Size is generally indicated on the insulation cover.)

V. Factors affecting voltage drop

A. Length of wire

B. Size of wire

C. Number of amps flowing through wire

D. Type of conductor

VI. Procedure to follow in wiring

A. Draw the schematic diagram

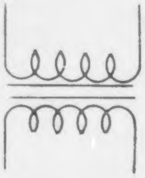
B. Draw the wiring diagram

C. Use the wiring diagram

INFORMATION SHEET

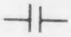
VII. Electrical schematic symbols

A. Transformer

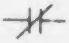


B. Contacts

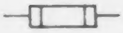
1. Normally open



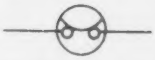
2. Normally closed



C. Fuse

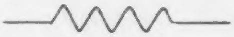


D. Fixed bimetal thermostat

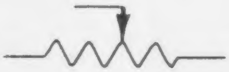


E. Resistor or load

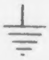
1. Fixed



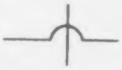
2. Variable



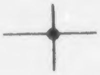
F. Ground connection



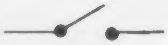
G. Wire crossover



H. Wire connection

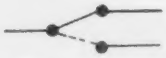


I. Single pole, single throw switch

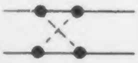


INFORMATION SHEET

J. Three-way switch

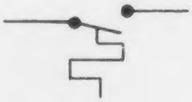


K. Four-way switch

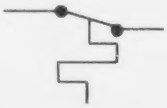


L. Thermostat

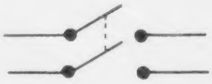
1. Closes on rise



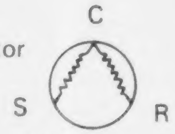
2. Opens on rise



M. Double pole, single throw switch

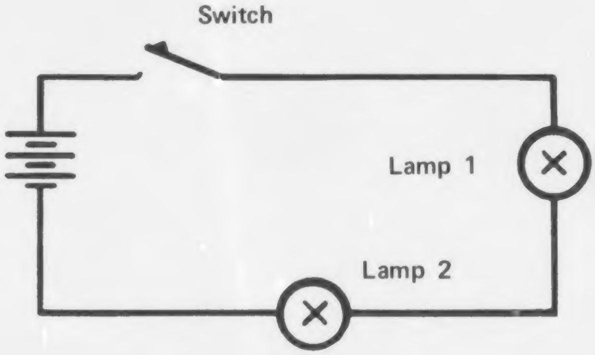


N. Single phase motor



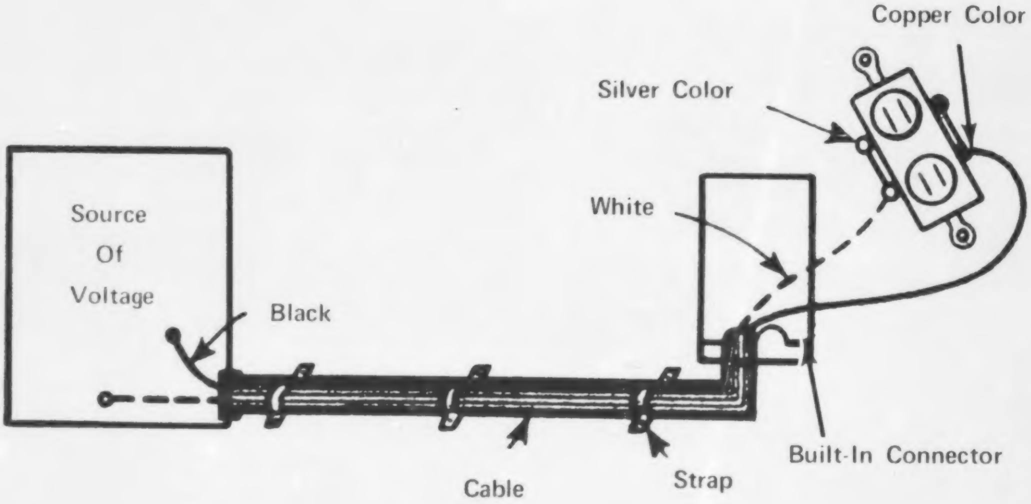
VIII. Schematic diagram vs wiring diagram

A. Schematic

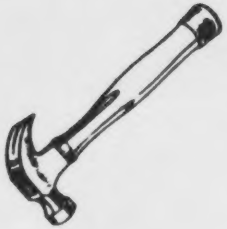


INFORMATION SHEET

B. Wiring diagram


Copper Color
Silver Color
Source
Of
Voltage
White
Black
Built-In Connector
Cable
Strap

Electrical Wiring Tools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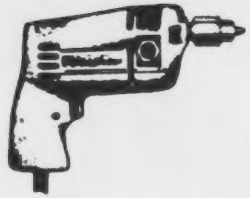
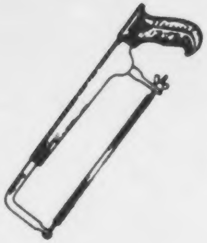
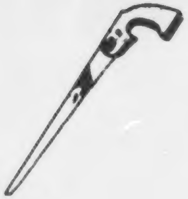
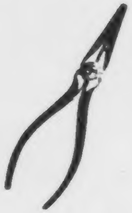
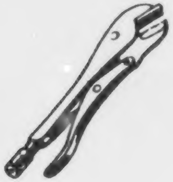
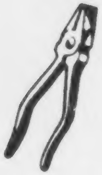

Electric Drill

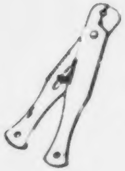

Hacksaw

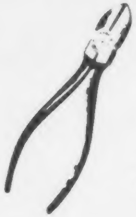

Keyhole Saw


Needle Nose Pliers


Vise-Grip Pliers


Linemans Pliers


Wire Cutter
or Stripper

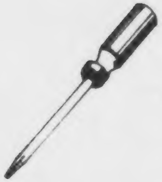

Diagonal Pliers

TM 1

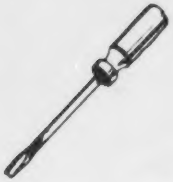
AgM - 95-D

Electrical Wiring Tools

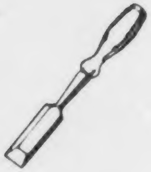
(Continued)



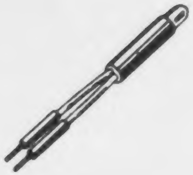
Phillips Screwdriver



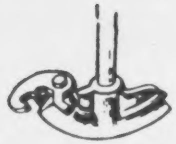
Standard Screwdriver



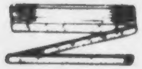
Wood Chisel



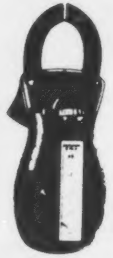
Test Light



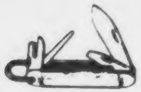
Conduit Bender



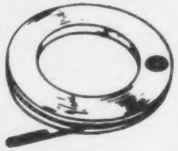
Tape or Rule



Amp-Volt Meter



Pocket Knife



Fish Tape and Reel

ELECTRIC WIRING PRACTICES
UNIT III

JOB SHEET #1--WIRE A LIGHTING OUTLET CONTROLLED BY A SINGLE POLE SWITCH WITH A DUPLEX RECEPTACLE

I. Tools and materials

A. Standard screwdriver

B. Lineman's pliers

C. Needle nose pliers

D. Knife or stripper

E. Lighting outlet

F. Octagon box

G. Single pole switch

H. Switch boxes, two

I. Duplex receptacle

J. Plywood, 2' x 3' x 1/4"

K. 12-2 or 14-2 NM cable

L. Safety glasses

M. Solderless connectors

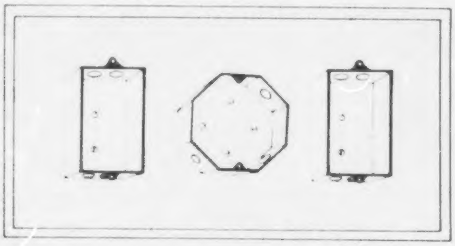
N. Appropriate fasteners

II. Procedure

(NOTE: Safety glasses should be worn at all times.)

A. Attach boxes to plywood (Figure 1)

FIGURE 1



JOB SHEET #1

B. Measure cable and cut to proper length

(NOTE: Leave approximately 8" on each end sticking through the boxes.)

C. Remove plugs from each box so cable can be installed

D. Loosen screw in boxes on holddowns and install cables (Figure 2)

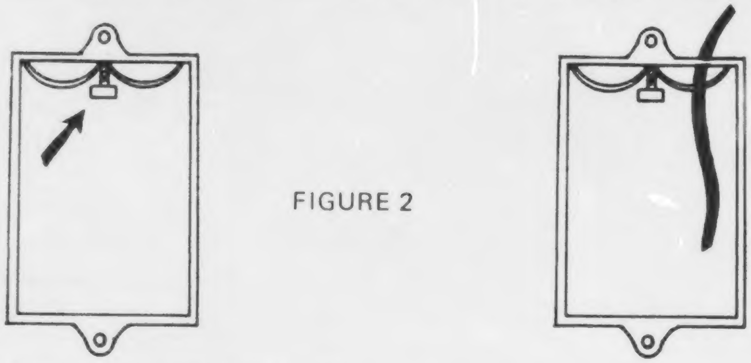


FIGURE 2

E. Tighten screws and holddowns

F. Remove 6" of outer insulation from the cable using the stripper or knife

(NOTE: Be careful not to cut your hand when using a knife.)

G. Remove 1/2" to 3/4" of insulation from the end of each wire

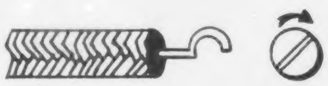
(CAUTION: Do not scratch or knick the wire when removing insulation.)

H. Connect single pole switch to wire

(NOTE: Connect the white wire to the brass screw and black wire to the silver screw. This is the only time a white wire will be connected to the brass screw and black wire connected to the silver screw. The black wire is referred to as the traveler wire on the switch leg.)

I. Place wires on terminals as shown in Figure 3

FIGURE 3

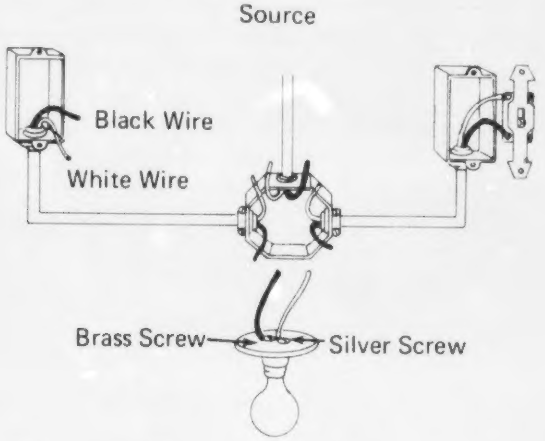


JOB SHEET #1

J. Connect the black wire to brass screw in lighting outlet

K. Connect the white wire from switch to black wire from source (Figure 4)

FIGURE 4



L. Install duplex receptacle

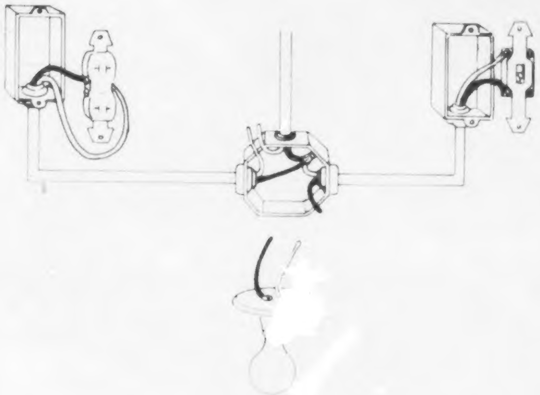
M. Connect black wire to brass screw on receptacle

N. Connect the white wire to silver screw on receptacle

O. Connect the black wire from the receptacle to the connection of black wire from the source in the octagon box with a solderless connector (Figure 5)

(NOTE: Twist the wire in the solderless connector so no bare wire is showing. If bare wire is showing, it may be necessary to tape it.)

FIGURE 5



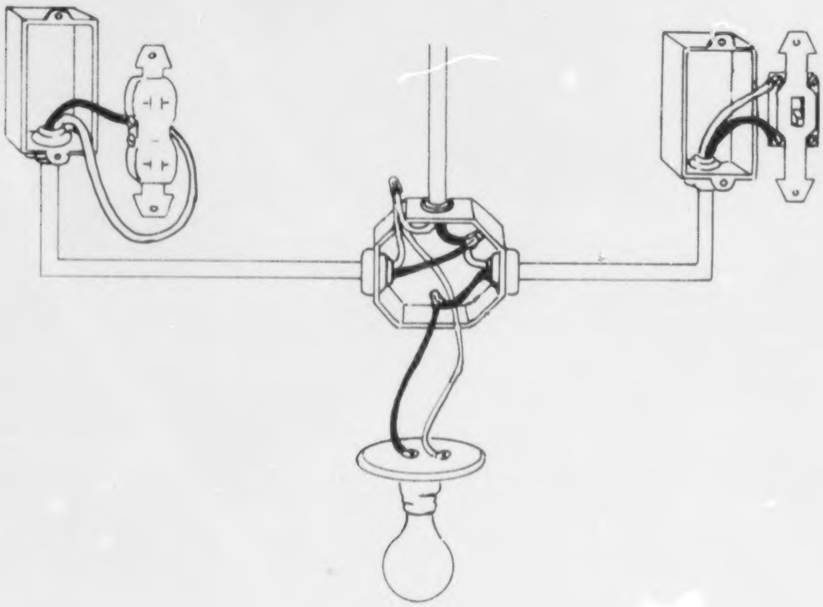
JOB SHEET #1

P. Cut a short pigtail wire (white) and connect to silver screw on lighting outlet

Q. Connect white wire from source, white wire from receptacle, and white pigtail from lighting outlet with a solderless connector inside the octagon box (Figure 6)

(NOTE: Make sure no bare wire is showing.)

FIGURE 6



(NOTE: Figure 6 is a diagram of the finished product. Turn in to instructor for evaluation.)

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #2--WIRE THREE DUPLEX RECEPTACLES USING NONMETALLIC CABLE

I. Tools and materials

- A. Standard screwdriver
- B. Lineman's pliers
- C. Needle nose pliers
- D. Knife or stripper
- E. Duplex receptacles, three
- F. Switch boxes for receptacles, three
- G. Duplex receptacle cover plates, three
- H. Plywood, 2' x 3' x 1/4"
- I. 12-2-G NM wire, three pieces, 24 inches long

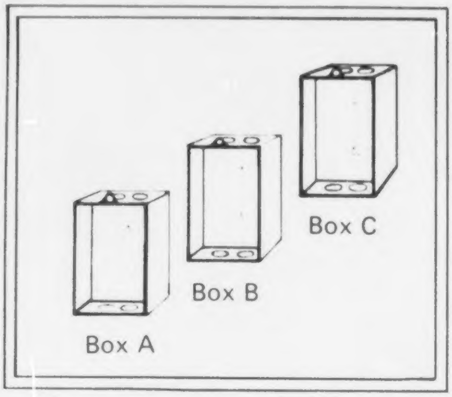
  (NOTE: Mark wires no. 1, no. 2, and no. 3.)
- J. Safety glasses

II. Procedure

(NOTE: Safety glasses should be worn at all times.)

- A. Secure boxes for receptacles to demonstration board (Figure 1)

FIGURE 1

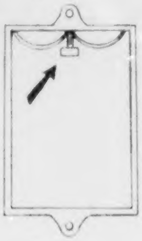


JOB SHEET #2

B. Remove knock-out plugs on boxes A and B on both ends but remove only one knock-out on box C

C. Loosen screw inside all three boxes (Figure 2)

FIGURE 2



D. Start with box C and place wire 1 under screw plate, allowing six inches to extend from box; tighten screw

(CAUTION: Tighten screw firmly but do not cut insulation. See Figure 3.)

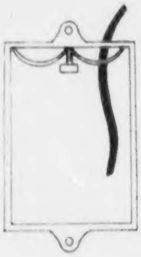


FIGURE 3

E. Place remaining end of wire 1 under screw plate of box B, allowing six inches to extend from the box; tighten screw

F. Place wire 2 in box B under screw plate of box, allowing six inches to extend from the box; tighten screw

G. Place the remaining end of wire 2 in box A under screw plate of box, allowing six inches to extend from box; tighten screw

H. Place wire 1 under screw plate of box A, allowing six inches to extend from the box

I. Remove approximately five inches of the outside insulation on each wire extending from switch box

(NOTE: Remember to use caution in removing insulation.)

JOB SHEET #2

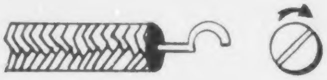
J. Remove approximately 1/2'' to 3/4'' of insulation from each wire extending from switch boxes

(NOTE: Remember to use caution in removing insulation from wires.)

K. Start with box C and attach black *hot wire* to brass side of receptacle

(NOTE: Wire should be placed around terminals according to the direction the screw tightens. See Figure 4.)

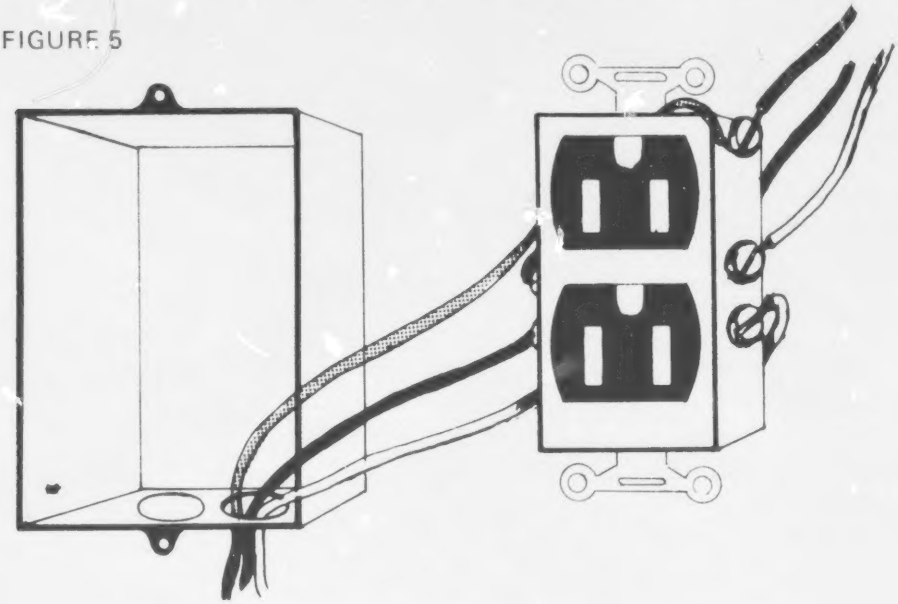
FIGURE 4



L. Attach white *neutral wire* to silver side of receptacle (Figure 5)

M. Attach bare *ground wire* to the top of receptacle (Figure 5)

FIGURE 5



N. Follow same procedure for attaching wires to receptacles A and B

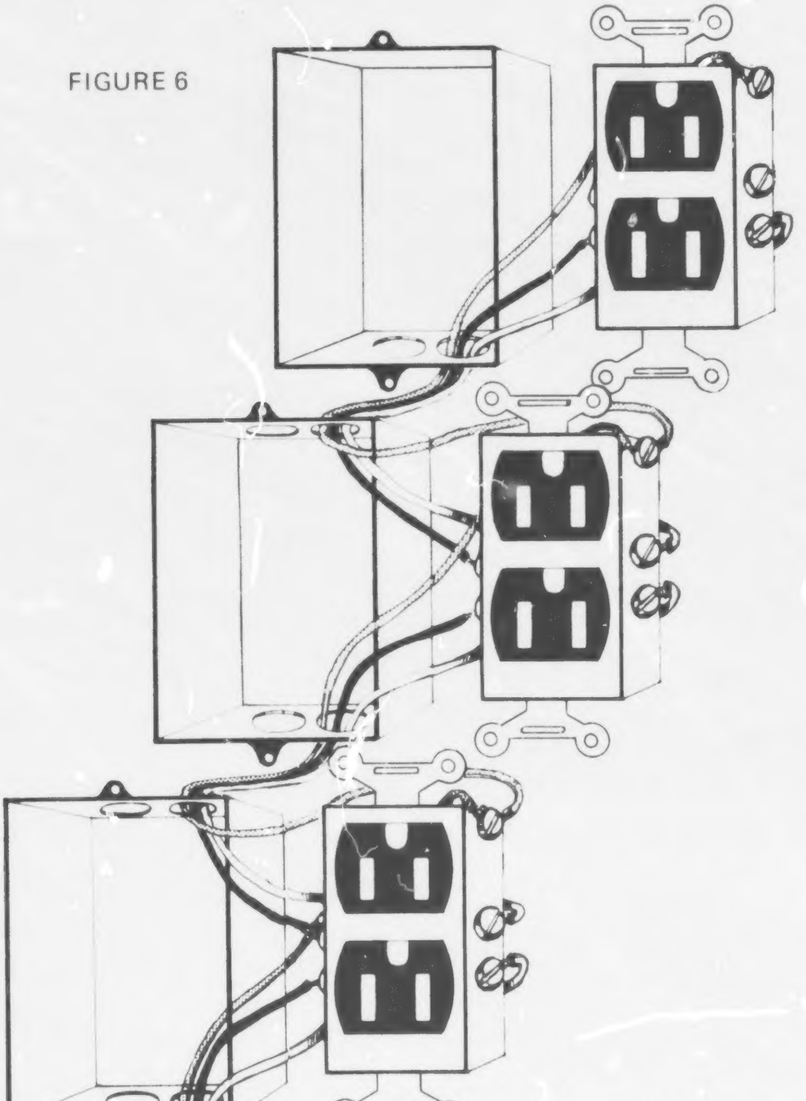
O. Assemble wires with receptacle and place in box; attach cover plate

JOB SHEET #2

P. Check with instructor for approval before attaching wire 3 to electrical source

(NOTE: Figure 6 is a diagram of the finished product. Turn in to instructor for evaluation.)

FIGURE 6



ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #3--WIRE LIGHTING OUTLET CONTROLLED BY TWO THREE-WAY SWITCHES

I. Tools and materials

A. Standard screwdriver

B. Lineman's pliers

C. Needle nose pliers

D. Knife or stripper

E. Lighting outlet

F. Octagon box

G. Three-way switches and cover plates, two

H. Switch boxes, two

I. Black tape for tracer marking

J. 12/3 NM cable, two pieces, two feet long

(NOTE: In this job, the 12/3 NM cable contains three wires. White, the neutral, will be used as a hot carrier and requires a tracer wire marking. The black wire will be the hot wire, and the red wire will be used as a hot carrier wire.)

K. 12/2 NM cable, one piece, two feet long

L. Plywood, 2' x 3' x 1/4"

M. Safety glasses

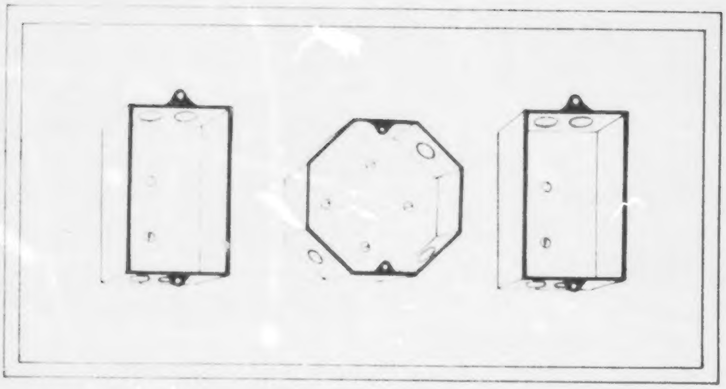
II. Procedure

(NOTE: Safety glasses should be worn at all times.)

A. Attach octagon box and both switch boxes to plywood (Figure 1)

JOB SHEET #3

FIGURE 1



B. Remove approximately six inches of the outside insulation on each end of the NM cable

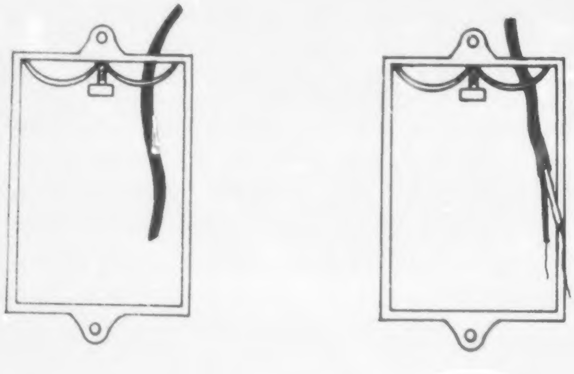
C. Remove knock-out plug from switch box and loosen screw in box; place one 12/3 NM cable under plate and allow approximately eight inches to extend from box; tighten screw

(CAUTION: Be careful not to tighten screw too tightly because it will cut the insulation on the wire.)

D. Remove 1/2" to 3/4" of insulation from wire

(CAUTION: This should be done in such a manner as to not scratch or mark the wire. See Figure 2.)

FIGURE 2



E. Remove knock-out plugs on octagon box located directly across from each other

F. Use the remainder of wire extending from switch box and run to octagon box; use same procedure for fastening wire to octagon box as in fastening to switch box

JOB SHEET #3

G. Repeat the same procedure with other 12/3 NM cable, connecting the other switch box to the octagon box

(NOTE: While conducting this step, you will need to repeat steps C, D, and F.)

H. Remove six inches of outside insulation from both ends of the 12/3 NM cable

I. Knock out one of the remaining plugs in the octagon box

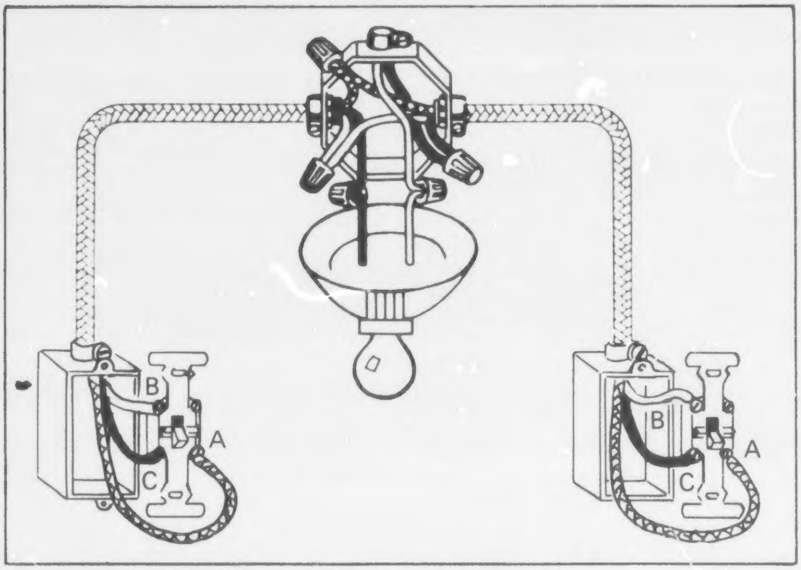
J. Pull eight inches of the cable through the box and secure to clamp; remove 1/2" to 3/4" of insulation from each wire

(CAUTION: This should be done in such a manner as to not scratch or mark the wire.)

(NOTE: The other end of this cable extending from octagon box will be connected to source at completion of job.)

K. Connect black wire to three-way switch on screw C in switch box 1; connect red wire to screw A and white wire with tracer to screw B (Figure 3)

FIGURE 3



JOB SHEET #3

L. Connect black wire to the other three-way switch on screw C in switch box 2, the red wire to screw A, and the white wire with tracer to screw B (Figure 3)

(NOTE: Wire should be placed around terminals on switch according to the way the screw turns.)

M. Connect the two red wires in the octagon box together using a pigtail splice

N. Connect the two white wires with tracers in the octagon box using a pigtail splice and connecting cap

O. Connect the black wire from the source to the black wire going to switch 1 using a pigtail splice

P. Connect the black wire from switch 2 to the brass screw on the light fixture

Q. Connect the white wire from source to the silver screw on the light fixture

(CAUTION: Check with instructor before performing the next three steps.)

R. Place wires in switch boxes and fasten switches to the boxes; install switch cover plates

S. Place wires in octagon box and fasten light fixture to box

(CAUTION: Do not overtighten fixture.)

T. Connect wire extending from octagon box to source

U. Turn switches off and on to see if job is correct

ELECTRICAL WIRING PRACTICES
UNIT III

JOB SHEET #4--WIRE A RANGE PLUG

I. Tools and materials

  A. Lineman's pliers

  B. Needle nose pliers

  C. Standard screwdriver

  D. Pocket knife

  E. Wire stripper

  F. Range plug

  G. 10-3-G or 8-3-G cable

  H. Plywood, 2' x 3' x 1/4"

  I. Safety glasses

  J. Cable connectors

  K. Switch box

  L. Octagon box

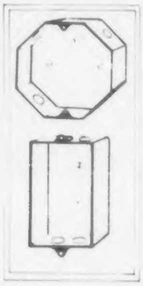
II. Procedure

(NOTE: Safety glasses should be worn at all times.)

  A. Remove cover from range plug

  B. Install switch box and octagon box on board (Figure 1)

FIGURE 1



JOB SHEET #4

C. Remove correct size knock-out plug from switch box

D. Install proper cable connector

E. Cut piece of cable to run from octagon box to range plug and install

(NOTE: Leave at least 8'' of cable extending past the surface of the switch box.)

F. Strip cable's outer insulation at least 6"

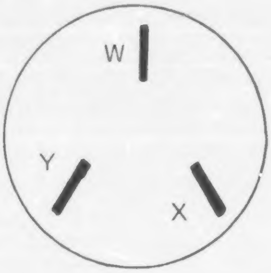
G. Strip 1/2" to 3/4" of insulation from end of each wire

(NOTE: Care should be taken not to knick or scratch wire.)

H. Connect the bare wire to grounding terminal in switch box

I. Connect the black, red, and white wires to terminal on range plug (Figure 2)

FIGURE 2

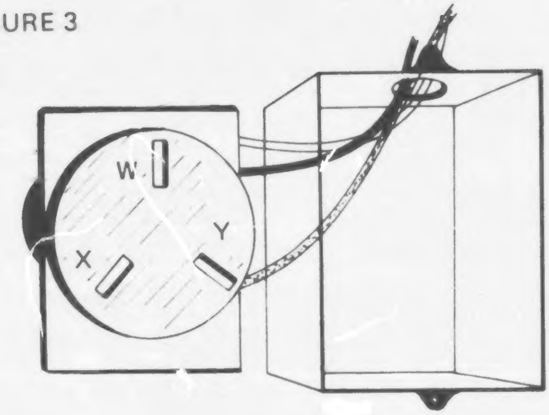


(NOTE: White conductor should be connected to terminal W or ground. Red and black conductors should be connected to terminals X and Y.)

(CAUTION: This device is for 240 volts and should be connected properly and grounded.)

JOB SHEET #4

FIGURE 3



(NOTE: Finished product should look similar to Figure 3. Turn in to instructor for evaluation.)

ELECTRICAL WIRING PRACTICES
UNIT III

TEST

NAME________________________ SCORE________________________

1. Match terms associated with electrical wiring to the correct definitions. Place the appropriate numbers in the blanks provided. Terms and definitions are continued on the following page.

_____a. Device which contains the splices when a circuit is tapped for an appliance or a light

_____b. Box-like device which is used to bring the wires to the location where a switch or outlet is installed; handy box

_____c. Thin-walled steel pipe used to protect electrical wires

_____d. Two or more stranded conductors grouped together in a flexible covering

_____e. Switch used to break the current in a single place

_____f. Two or more conductors grouped together inside an overall covering

_____g. Switch used to control lights and motors from two different places

_____h. Switch used to control lights and motors from three or more different places

_____i. Plan which shows the electric circuit with items arranged and appearing so the job of connecting will be simplified

_____j. Tool used to measure wire diameter

_____k. Line-type illustration using standardized symbols to represent an electrical circuit

1. Wire gauge
2. Four-way switch
3. Three-way switch
4. Single pole toggle switch
5. Conduit
6. Receptacle outlet
7. Outlet box
8. Cord
9. Cable
10. Wiring diagram
11. Schematic diagram

______l. Outlet box with a blank cover used to contain splices of a circuit

______m. Measure of wire diameter

______n. Device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections

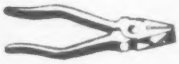
______o. Single conductor which carries electricity

______p. Wire, cords, or cables which carry the electricity or through which electricity flows

______q. Having slots or contact blades paired so as not to allow for a different contact arrangement

12. Polarized
13. Wire
14. Wire size
15. Junction box
16. Terminal
17. Conductors

2. Identify the following tools used in electrical wiring.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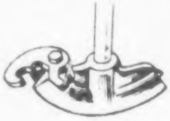
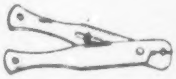
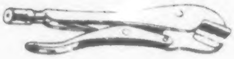
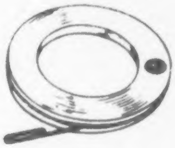

b. ______________


c. ______________

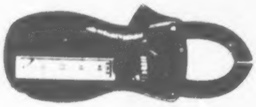

d. ______________

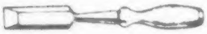
e. ______________


f. ______________

g. ______________

h. ______________


i. ______________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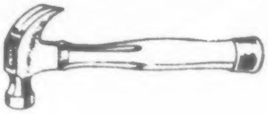
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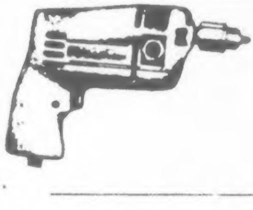
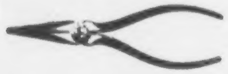

l. ______________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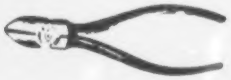
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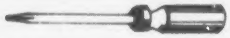
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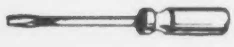
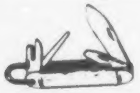
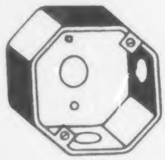
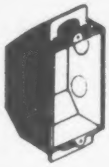

p. ____________________

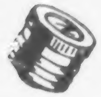
q. ____________________

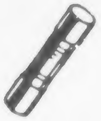

r. ____________________

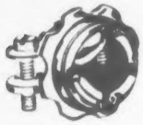
3. Identify the following electrical devices.

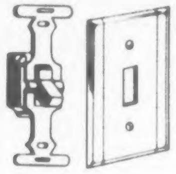

a. ____________________

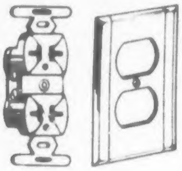

b. ____________________


c. ____________________


d. ____________________


e. ____________________


f. ____________________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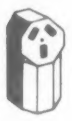
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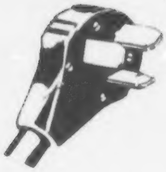
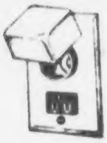
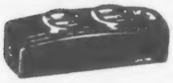


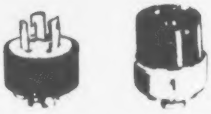
i. ____________________



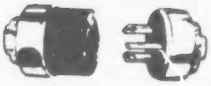
j. ____________________



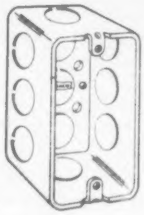
k. ____________ ______



l. ____________________



m. ____________________



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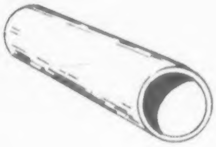
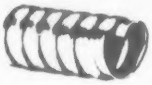
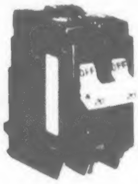


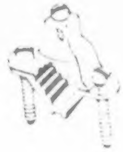
o. ____________________



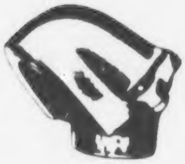
p. ____________________

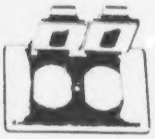


q. ____________________

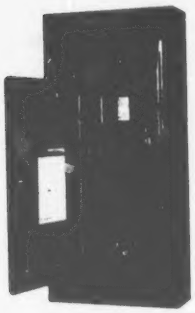


r. ____________________





s. ______________________ t. ______________________



u. ______________________

4. Complete the following chart on conductors, types, and uses.

ITEM	TYPE	USE
Wire	A	______________________
Wire	__________	Inside of conduit, dry and wet locations
Wire	USE	______________________
__________	TW (Low voltage)	Low voltage alarm or relay controls
Cord	HPN	______________________
Cord	S	______________________
Cord	HC	______________________
Cord	__________	Portable tools
Cord	__________	Vacuum cleaners, mixers
__________	Triplex	Outside, overhead service
Cable	__________	Underground, feeder and branch circuits
Cable	__________	Inside, dry locations

5. Name three factors affecting voltage drop.

a. ______________________________

b. ______________________________

c. ______________________________

6. Arrange in order the procedure to follow in wiring. Place a "1" in front of the first step, a "2" in front of the second, and so on.

_____a. Use the wiring diagram

_____b. Draw the schematic diagram

_____c. Draw the wiring diagram

7. Match the electrical schematic symbols on the right to the correct names. Place the correct numbers in the blanks provided.

_____a. Contacts, normally open

_____b. Fixed bimetal thermostat

_____c. Ground connection

_____d. Single pole, single throw switch

_____e. Single phase motor

_____f. Thermostat, opens on rise

_____g. Transformer

_____h. Fuse

_____i. Resistor or load, fixed

_____j. Wire connection

_____k. Three-way switch

_____l. Wire crossover

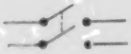
_____m. Double pole, single throw switch

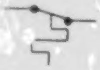
_____n. Four-way switch

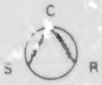
_____o. Contacts, normally closed

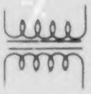
_____p. Thermostat, closes on rise

_____q. Resistor or load, variable

1. 

2. 

3. 

4. 

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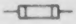
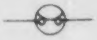
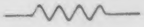
6. 

7. 

8. 

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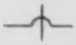
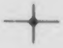
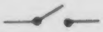
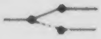
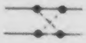
10. 

11. 

12. 

13. 

14. 

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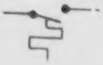
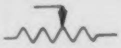
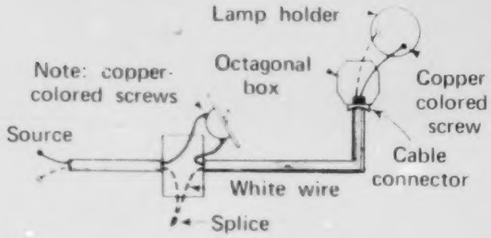
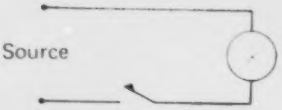
16. 

17. 

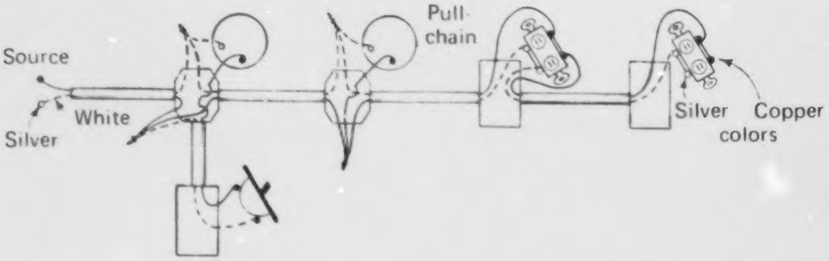
8. Distinguish between the following drawings by writing *schematic* or *wiring* under the appropriate diagrams.


Lamp holder
Note: copper-colored screws
Octagonal box
Copper colored screw
Source
Cable connector
White wire
Splice

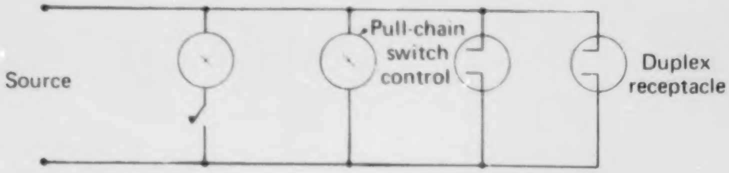
a. ____________________



b. ____________________


Source
White
Silver
Pull-chain
Silver
Copper colors

c. ____________________


Source
Pull-chain switch control
Duplex receptacle

d. ____________________

9. Demonstrate the ability to:

a. Wire a lighting outlet controlled by a single pole switch with a duplex receptacle.

b. Wire three duplex receptacles using nonmetallic cable.

c. Wire a lighting outlet controlled by two three-way switches.

d. Wire a range plug.

(NOTE: If these activities have not been accomplished prior to test, ask the instructor when they should be completed.)

ELECTRICAL WIRING PRACTICES
UNIT III

ANSWERS TO TEST

1. Match terms associated with electrical wiring to the correct definitions. Place the appropriate numbers in the blanks provided. Terms and definitions are continued on the following page.

_6_ a. Device which contains the splices when a circuit is tapped for an appliance or a light

_7_ b. Box-like device which is used to bring the wires to the location where a switch or outlet is installed; handy box

_5_ c. Thin-walled steel pipe used to protect electrical wires

_8_ d. Two or more stranded conductors grouped together in a flexible covering

_4_ e. Switch used to break the current in a single place

_9_ f. Two or more conductors grouped together inside an overall covering

_3_ g. Switch used to control lights and motors from two different places

_2_ h. Switch used to control lights and motors from three or more different places

_10_ i. Plan which shows the electric circuit with items arranged and appearing so the job of connecting will be simplified

_1_ j. Tool used to measure wire diameter

_11_ k. Line-type illustration using standardized symbols to represent an electrical circuit

_15_ l. Outlet box with a blank cover used to contain splices of a circuit

1. Wire gauge
2. Four-way switch
3. Three-way switch
4. Single pole toggle switch
5. Conduit
6. Receptacle outlet
7. Outlet box
8. Cord
9. Cable
10. Wiring diagram
11. Schematic diagram
12. Polarized

14 m. Measure of wire diameter

16 n. Device attached to the end of a wire or cable or to an electrical apparatus for convenience in making connections

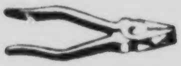
13 o. Single conductor which carries electricity

17 p. Wire, cords, or cables which carry the electricity or through which electricity flows

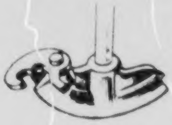
12 q. Having slots or contact blades paired so as not to allow for a different contact arrangement

13. Wire
14. Wire size
15. Junction box
16. Terminal
17. Conductors

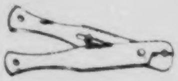
2. Identify the following tools used in electrical wiring.



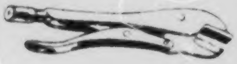
a. Lineman's pliers



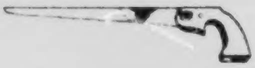
b. Conduit bender



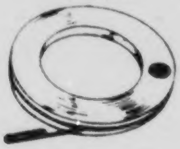
c. Wire cutter or stripper



d. Vise-grip pliers

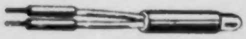


e. Keyhole saw

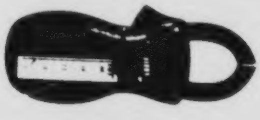


f. Fish tape and reel

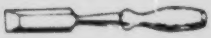
g. Hacksaw



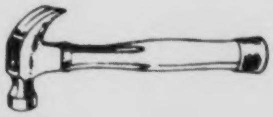
h. Test light



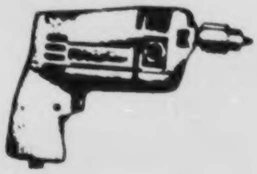
i. Amp-volt meter



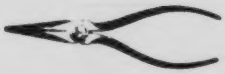
j. Wood chisel



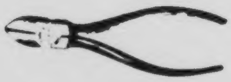
k. Hammer



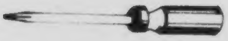
l. Electric drill



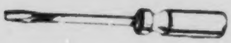
m. Needle nose pliers



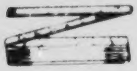
n. Diagonal pliers



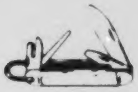
o. Phillips screwdriver



p. Standard screwdriver

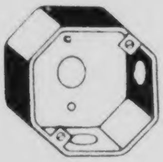


q. Tape or rule

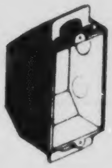


r. Pocket knife

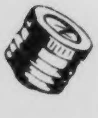
3. Identify the following electrical devices.



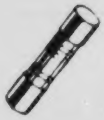
a. Octagon box



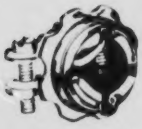
b. Beveled cornered wall box with plaster ears



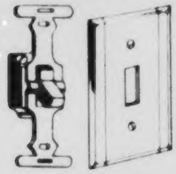
c. Edison base plug fuse



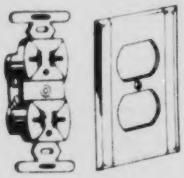
d. Cartridge fuse



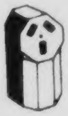
e. Connector



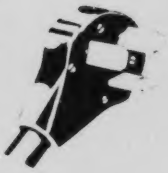
f. Toggle switch and cover



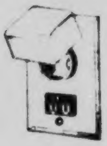
g. Duplex grounding receptacle and cover



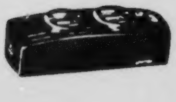
h. Surface mount range receptacle



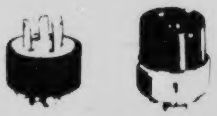
i. Heavy duty plug



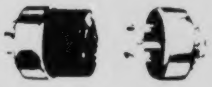
j. Fuse box cover with grounded outlet for fractional horsepower motor protection



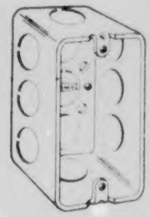
k. Surface mount duplex grounding receptacle



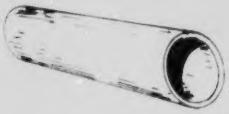
l. Three wire twist lock connector and plug



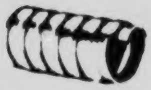
m. Crow foot plug and connector



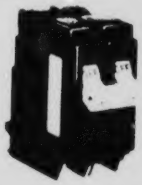
n. Handy box



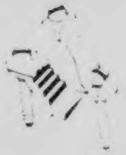
o. Rigid steel conduit



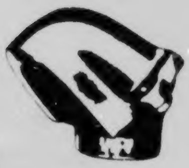
p. Flexible steel conduit



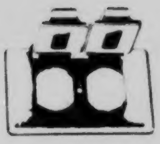
q. 240-volt breaker



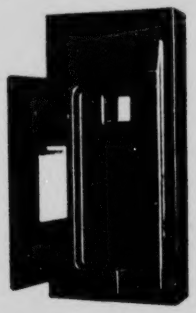
r. Ground clamp



s. Service entrance cap (weather head)



t. Weatherproof wallplate



u. Distribution panel

4. Complete the following chart on conductors, types, and uses.

ITEM	TYPE	USE
Wire	A	Heating appliances within apparatus, dry locations
Wire	TW	Inside of conduit, dry and wet locations
Wire	USE	Trench, underground
Wire	TW (Low Voltage)	Low voltage alarm or relay controls
Cord	HPN	Heater cord
Cord	S	Hard usage, welders, large motors
Cord	HC	Iron, heaters
Cord	SJ	Portable tools
Cord	SV	Vacuum cleaners, mixers
Cable	Triplex	Outside, overhead service
Cable	UF	Underground, feeder and branch circuits
Cable	NM	Inside, dry locations

5. Name three factors affecting voltage drop.

(NOTE: Any three of the following are acceptable.)

a. Length of wire

b. Size of wire

c. Number of amps flowing through wire

d. Type of conductor

6. Arrange in order the procedure to follow in wiring. Place a "1" in front of the first step, a "2" in front of the second, and so on.

3 a. Use the wiring diagram

1 b. Draw the schematic diagram

2 c. Draw the wiring diagram

7. Match the electrical schematic symbols on the right to the correct names. Place the correct numbers in the blanks provided.

5 a. Contacts, normally open

7 b. Fixed bimetal thermostat

9 c. Ground connection

12 d. Single pole, single throw switch

3 e. Single phase motor

2 f. Thermostat, opens on rise

4 g. Transformer

6 h. Fuse

8 i. Resistor or load, fixed

11 j. Wire connection

13 k. Three-way switch

10 l. Wire crossover

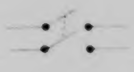
1 m. Double pole, single throw switch

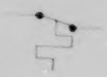
14 n. Four-way switch

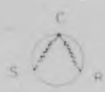
15 o. Contacts, normally closed

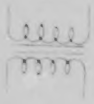
16 p. Thermostat, closes on rise

17 q. Resistor or load, variable

1. 

2. 

3. 

4. 

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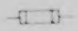
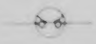
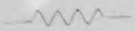
6. 

7. 

8. 

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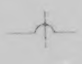
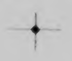
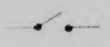
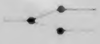
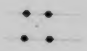
10. 

11. 

12. 

13. 

14. 

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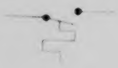
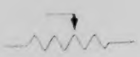
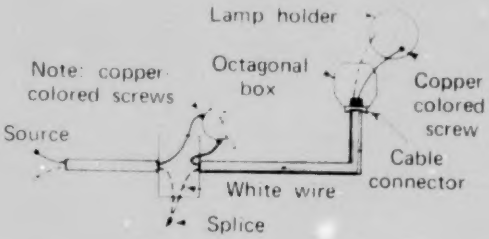
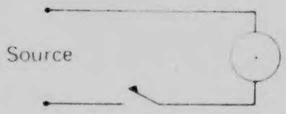
16. 

17. 

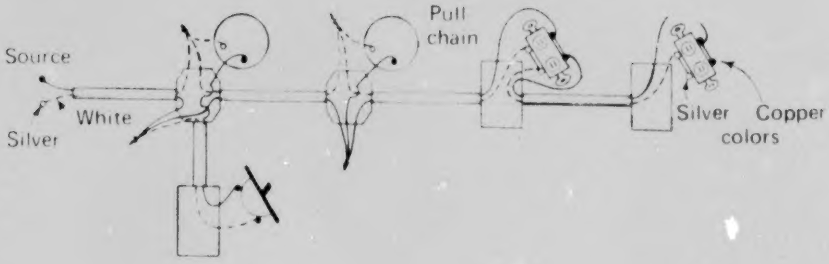
8. Distinguish between the following drawings by writing *schematic* or *wiring* under the appropriate diagrams.


Lamp holder
Note: copper colored screws
Octagonal box
Copper colored screw
Source
Cable connector
White wire
Splice

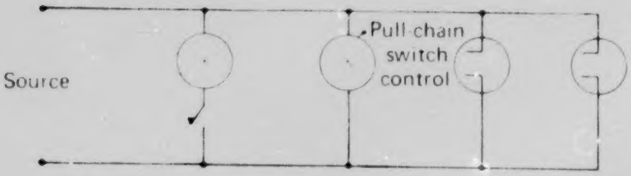
a. Wiring



b. Schematic


Pull chain
Source
White
Silver
Silver
Copper colors

c. Wiring


Pull chain switch control
Source

d. Schematic

9. Demonstrate the ability to:

   a. Wire a lighting outlet controlled by a single pole switch with a duplex receptacle.

   b. Wire three duplex receptacles using nonmetallic cable.

c. Wire lighting outlet controlled by two three-way switches.

d. Wire a range plug.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

ELECTRIC MOTORS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of an induction-run motor and select electric motors according to their starting circuits and capabilities. The student should be able to identify types of bearings and motor enclosures and be able to interpret nameplate information. The student should be able to demonstrate the ability to disassemble an electric motor, clean the motor, and reassemble it. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with electric motors to the correct definitions.
2. Identify types of A.C. single-phase, induction-run motors.
3. Classify types of A.C. single-phase, induction-run motors according to their characteristics.
4. State the reason for the built-in capacitor in a capacitor-start motor.
5. Identify the parts of an induction-run motor.
6. Name requirements of an electric motor.
7. Name factors to consider in selecting electric motors.
8. Discuss in a short paragraph the thumb rules to follow in estimating the size of an electric motor.
9. Complete a chart on characteristics of electric motors.
10. Select from a list factors to consider when replacing electric motors.
11. Identify the types of bearings used in electric motors.
12. Distinguish between types of bearings used in electric motors according to their characteristics.
13. Identify types of motor enclosures.
14. Match types of motor enclosures to their uses.
15. Name reasons for having protective devices on motors.

16. Name causes of motor damage (burn-out).
17. Name common motor enemies.
18. Name types of sensing devices used in switching electric motors.
19. Identify information found on the nameplate of a motor.
20. Demonstrate the ability to disassemble, clean, and reassemble electric motors.

ELECTRIC MOTORS
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide students with objective sheet.

   B. Provide students with information, assignment, and job sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedures for completion of assignment and job sheets.

   G. Give test.

II. Unit references:

   A. *Farm Utility Building*. Athens, Georgia: American Association of Vocational Instructional Materials, 1972.

   B. Morford, V. J. *Farm and Dairy Mechanics*. Minneapolis, Minnesota: Burgess Publishing Company.

   C. Brown, Robert H. *Farm Electrification*. New York: McGraw-Hill Book Company, Inc.

ELECTRIC MOTORS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

   A. Single-phase--Type of electrical service available to most farms; requires one transformer between power supplier and customer

   B. Split-phase motor--Cheapest electric motor available; used for easy starting loads

   C. Induction-run motor--Motor that runs by induced current and does not have windings in the rotor

   D. Repulsion-start motor--Motor that has windings in the rotor and also has brushes and a commutator

   E. Capacitor-start motor--Motor that has a capacitor in the starting windings

   F. Horsepower (hp)--Unit of mechanical power which is equal to 746 watts of electrical power

   G. Short circuit--Improper connection between hot and neutral wires or between hot wires

   H. Three-phase motor--Most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads

   I. RPM--Revolutions per minute

   J. Automatic motor control--Switch, relay, and/or a contactor capable of responding to a device that senses variations in temperature, humidity, light, and pressure

   K. Relay--Device capable of utilizing a sensing signal to open and close a (switch) circuit

   L. Commutator--Switch for reversing the direction of an electric motor

II. Types of A.C. single-phase, induction-run motors (Transparency 1)

   A. Split-phase

   B. Repulsion-start

INFORMATION SHEET

- C. Capacitor-start, capacitor-run
- D. Repulsion-start, capacitor-run

III. Characteristics of A.C. single-phase, induction-run motors

- A. Split-phase
  - 1. Cheapest electric motor available
  - 2. Available in sizes up to 1/3 hp
  - 3. Uses single-phase power
  - 4. Uses 120-volt and/or 240-volt service
  - 5. Used on easy starting loads

    Examples: Grinders, saws, washing machines
- B. Repulsion-start
  - 1. Uses single-phase power
  - 2. Uses 120-volt and/or 240-volt service
  - 3. Available in sizes from 1/6 to 10 hp
  - 4. Used on hard-to-start loads
- C. Capacitor-start, capacitor-run
  - 1. Uses single-phase power
  - 2. Has two capacitors
    - a. One for starting
    - b. One for running
  - 3. Available in sizes of 5, 7 1/2, and 10 hp
  - 4. Used on hard-to-start loads
- D. Repulsion-start, capacitor-run
  - 1. Uses single-phase power
  - 2. Is a combination of the two motors listed above

    (NOTE: The capacitor helps maintain running efficiency after the motor reaches operating speed.)
  - 3. Available in sizes of 1 to 15 hp

INFORMATION SHEET

IV. Reason for built-in capacitor--Gives additional starting torque without requiring additional amperage

V. Parts of induction-run motor (Transparency 2)

- A. Ventilated end bell or shield
- B. Stator and frame
- C. Thermal protection
- D. Centrifugal starting switch
- E. Sleeve bearing
- F. Rotor and fans
- G. Resilient mounting
- H. Neoprene thrust washers

VI. Requirements of an electric motor

- A. Must start the equipment load
- B. Must drive the load once it is started
- C. Must survive the abuse of the surroundings in which it operates

VII. Factors in selecting electric motors

- A. Type of electric power available

  Examples: Single-phase or three-phase
- B. Type and size of load
- C. Condition under which motor must operate

VIII. Thumb rules to follow in estimating motor size

- A. If equipment can be continuously operated by hand, a 1/4 hp electric motor will do the job
- B. If a piece of equipment is driven satisfactorily by a gasoline engine, the engine can normally be replaced with an electric motor of about 2/3 to 3/4 as much horsepower as the engine

  Example:

  To replace a 2 hp gasoline engine

  2 x 2/3 = 4/3

  Select a 1 1/2 hp electric motor

INFORMATION SHEET

IX. Characteristics of electric motors

MOTORS	STARTING ABILITY	STARTING CURRENT	STARTING MECHANISM	SPEED	VOLTAGE	COST & SIZE	APPLICATION
Split-Phase	Easy-to-start loads	Draws 6 to 8 times its normal running current	Two windings	Constant	120 or 240	Cheapest; 1/20 to 3/4 hp	Light farm work; used on such tools as pumps, grinders, and fans
Capacitor-Start, Induction-Run	Fairly difficult starting loads	Draws 3 to 6 times its full load	Two windings	Constant	120 or 240	25 to 40 percent more than the same size split-phase motor; 1/6 to 10 hp	Heavy duty farm use, such as air compressors, power tools, and feed grinders
Capacitor-Start, Capacitor-Run	Hard starting loads	Draws 3 to 5 times its normal running current	Has a running capacitor and a special slow starting mechanism	Constant 900 to 3600 rpm	120/240 under 2 hp 240 over 2 hp	20 percent more than capacitor-start, induction-run; 1/2 to 25 hp	General purpose farm use, such as pumps, blowers, and conveyors
Repulsion-Start, Induction-Run	Very heavy starting loads	Draws 3 times the running current	No starting winding but has two running windings	Constant 1200 to 1800 rpm	120 and 240	Similar to capacitor motors; 1/6 to 20 hp	Large general purpose farm use, such as feed mills, compressors, and silo unloaders
Universal	Easy starting		Brushes	Varies	120	Very economical; 1/20 to 1 hp	Shop tools, such as drills and saws
Shaded-Pole	Easy starting		Shaded windings, slow starting	Varies	120	Very economical; 1/20 to 1/4 hp	Small household fans, blowers, and hair dryers
Three-Phase	Variety of starting loads; usually for heavy, hard starting	Can be designated as having low, normal, or high; 3 to 4 times the running current	Self starting	Constant 400 to 3600 rpm	Voltage varies; used on large voltage	Expensive; 1/2 to many hundred hp	Used on loads requiring 10 hp or greater

INFORMATION SHEET

X. Replacing electric motors

  A. Horsepower rating must be the same or not more than one size larger up to 1 hp

  (NOTE: One size larger may indicate going from 1/2 hp to 1/3 hp.)

  B. Full-load speed, cycles, duty, and base must be the same

  C. Voltage should be 120 and/or 240

  (NOTE: A 240 voltage is preferred for 1/2 hp and larger.)

  D. Type should be the same

  (NOTE: Type should be the same as the motor being replaced or a type having equal or greater starting torque.)

XI. Types of bearings used in electric motors (Transparency 3)

  A. Sleeve

  B. Ball

XII. Characteristics of bearings used in electric motors (Transparency 3)

  A. Sleeve

    1. Oil-lubricated

    2. Shaft must be mounted parallel to the floor

  B. Ball

    1. No problem of oil loss

    2. Installed in any position

    3. Requires no greasing

XIII. Types of motor enclosures (Transparency 4)

  A. Open drip-proof

  B. Splash-proof

  C. Totally enclosed

  D. Totally closed explosion-proof

  (NOTE: This enclosure looks very similar to the totally enclosed motor enclosure.)

INFORMATION SHEET

XIV. Types of motor enclosures and their uses (Transparency 4)

- A. Open drip-proof--Used on most farms where water is not being sprayed
- B. Splash-proof--Designed for either indoor or outdoor use, such as milk barns or irrigation pumps
- C. Totally enclosed--Used where dust and grit are a problem
- D. Totally enclosed explosion-proof--Used around explosive materials, such as oil and gasoline

XV. Reasons for having protective devices on motors

- A. Protects against excessive overcurrent
- B. Prevents short circuits
- C. Prevents burning of windings
- D. Prevents overload

XVI. Causes of motor damage (burn-out)

- A. Load too heavy
- B. Machine locked or jammed
- C. Belt too tight or too loose
- D. Bearings worn or needing lubrication
- E. Voltage lower than nameplate indication
- F. Motor and equipment pulley out of line

XVII. Common motor enemies

- A. Dust
- B. Stray oil
- C. Moisture
- D. Bearing friction

INFORMATION SHEET

- E. Pulley misalignment
- F. Vibration
- G. Uneven wear
- H. Overload
- I. Inadequate wiring

XVIII. Sensing devices used in switching electric motors

- A. Temperature
- B. Humidity and moisture
- C. Light
- D. Pressure
- E. Timing

XIX. Nameplate information (Transparency 5, Assignment Sheet #1)

- A. Type of current

  (NOTE: This can be alternating or direct, single-phase, or three-phase.)

- B. Type of overload protection

  (NOTE: The terms *thermalguard* and *thermoguard* are manufacturer's identifications for specific overload protection devices built into the motor.)

- C. Horsepower
- D. RPM

  (NOTE: This indicates the speed of the motor shaft.)

- E. Temperature at which motor is to operate
- F. Hours that motor can be operated continuously
- G. Volts
- H. Type of enclosure

INFORMATION SHEET

I. Motor type

(NOTE: The various manufacturers usually use different letters and symbols to identify the various types of motors as to their starting mechanism. Very often the symbols *sp* for split-phase, *cs* for capacitor-start, and *rs* for repulsion-start are used.)

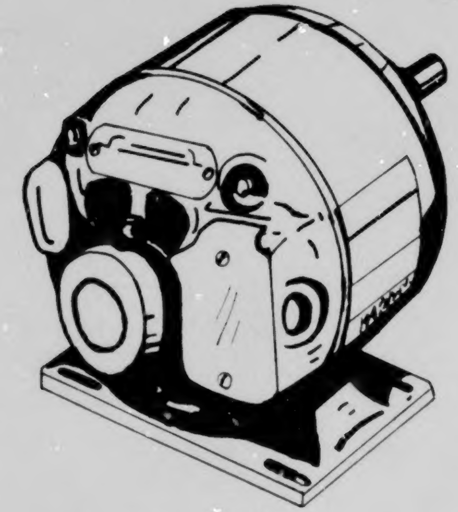
J. Type of frame

K. Cycle

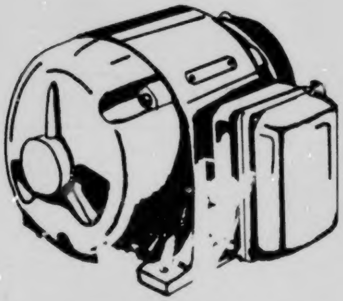
L. Serial number

(NOTE: This number should be used when writing to the manufacturer regarding the specific motor.)

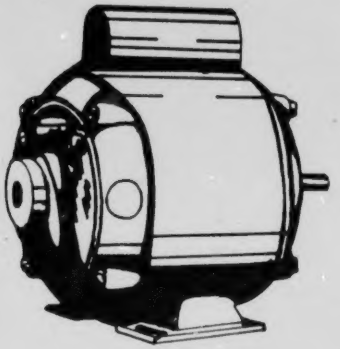
Types of Electric Motors



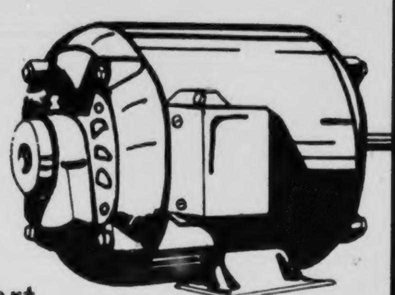
Split-Phase



Repulsion-Start, Capacitor-Run

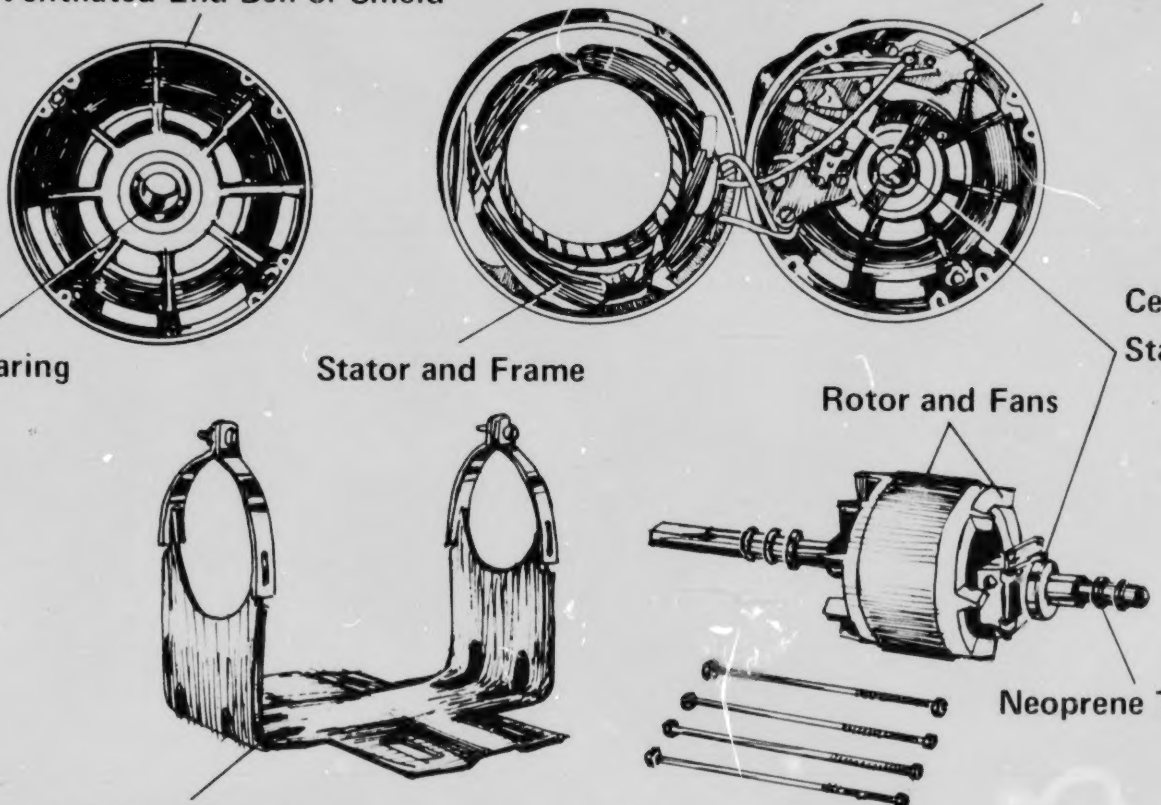


Capacitor-Start,
Capacitor-Run



Repulsion-Start

Parts of an Induction-Run Motor



Ventilated End Bell or Shield

Thermal Protection

Sleeve Bearing

Stator and Frame

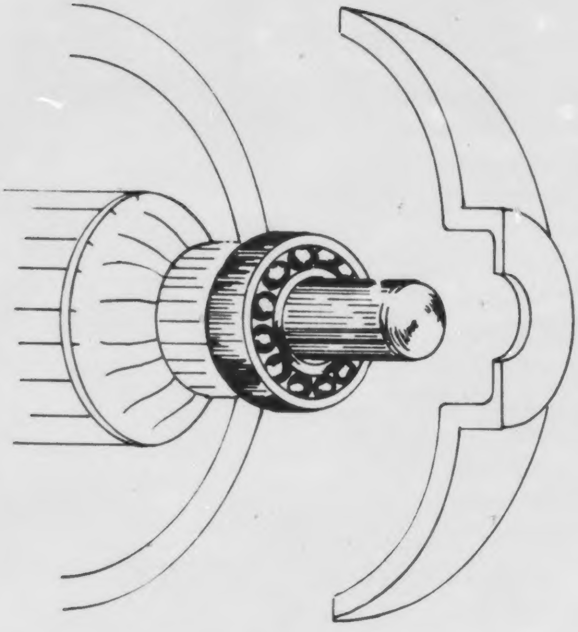
Centrifugal Starting Switch

Rotor and Fans

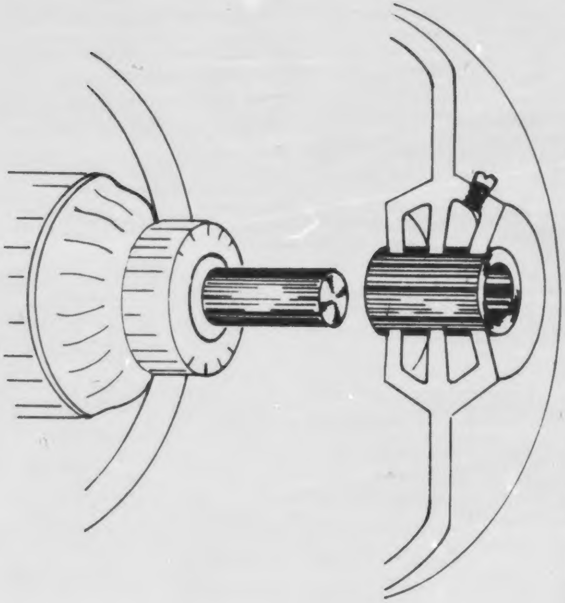
Neoprene Thrust Washers

Resilient Mounting

Types of Bearings

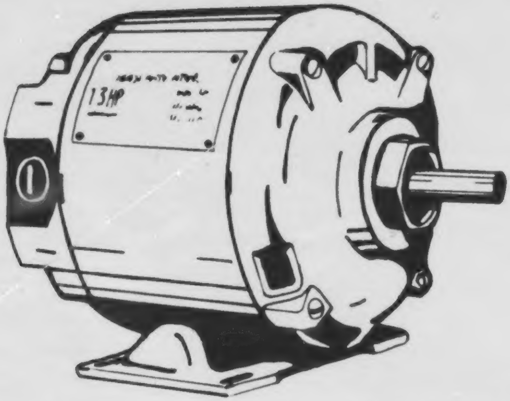


Ball

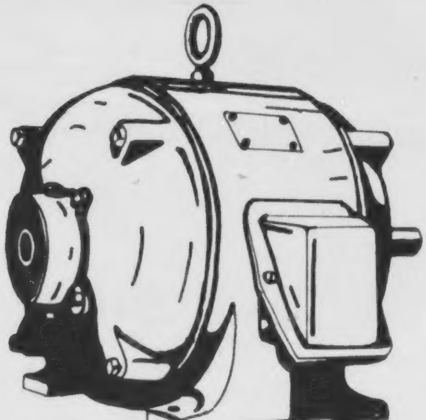


Sleeve

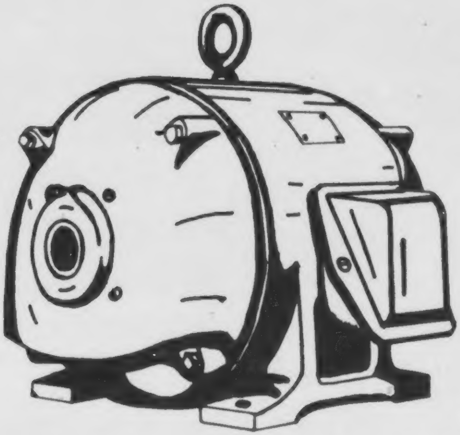
Types of Motor Enclosures



Open Drip-Proof

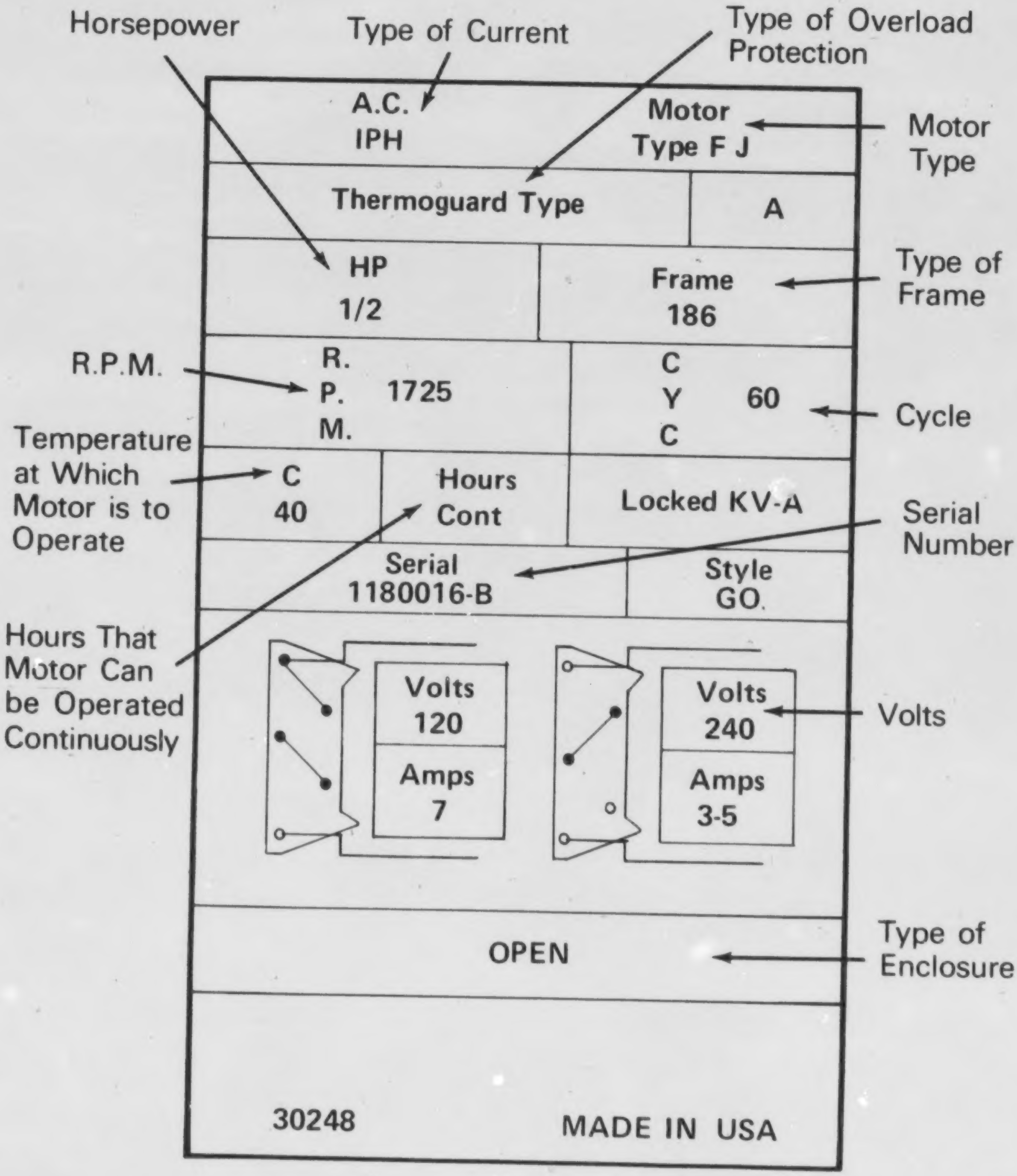


Totally Enclosed



Splash-Proof

Motor Nameplate Information


Horsepower
Type of Current
Type of Overload Protection
A.C.
IPH
Motor
Motor Type F J
Motor Type
Thermoguard Type
A
HP
1/2
Frame
186
Type of Frame
R.P.M.
R.
P. 1725
M.
C
Y 60
C
Cycle
Temperature at Which Motor is to Operate
C
40
Hours
Cont
Locked KV-A
Serial Number
Serial
1180016-B
Style
GO.
Hours That Motor Can be Operated Continuously
Volts
120
Amps
7
Volts
240
Amps
3-5
Volts
OPEN
Type of Enclosure
30248
MADE IN USA

ELECTRIC MOTORS
UNIT IV

ASSIGNMENT SHEET #1--RECORD NAMEPLATE INFORMATION

Select an electric motor that is in your school shop or at your home and complete the following questions. Return to instructor when finished for evaluation.

1. What is the horsepower of the motor?____________________
2. What does the horsepower fraction tell you?____________________
3. What is the rpm of the motor?____________________
4. What does rpm tell you about this particular motor?____________________
5. What is the recommended voltage to which this motor should be connected?____________________
6. What type of overload protection does the motor have?____________________
7. How long is the motor designed to operate?____________________
8. Under what temperature will the motor operate?____________________
9. What type of enclosure does the motor have?____________________
10. With this type of enclosure, where would you recommend using it? ____________________
11. What is the serial number?____________________
12. When would you use the serial number of a motor?____________________
13. At how many cycles per second does the motor operate?____________________
14. What is the motor type?____________________
15. What type of current does the motor use?____________________

ELECTRIC MOTORS
UNIT IV

JOB SHEET #1--DISASSEMBLE, CLEAN, AND REASSEMBLE ELECTRIC MOTORS

I. Tools and equipment

- A. Motor
- B. Standard screwdriver
- C. Open-end adjustable wrench
- D. Tire pump or vacuum cleaner
- E. Center punch
- F. Hammer
- G. Small socket wrench set
- H. Soft-faced mallet
- I. Nonflammable cleaning fluid
- J. Clean rags (lintless)

II. Procedure

- A. Disconnect motor and remove from mounting
- B. Clean out surface of motor
- C. Disconnect wires at motor

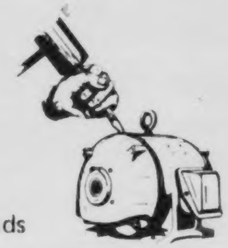
  (NOTE: Be sure and pay close attention to wire positions on motor terminals.)
- D. Remover motor pulley

JOB SHEET #1

E. Mark end bells

(NOTE: This is to keep end bells in their proper places. Using center punch, place one mark on pulley end bell and two marks on opposite end bell; mark housing same way. See Figure 1.)

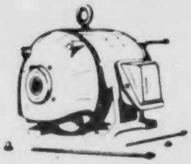
FIGURE 1



Mark Bell Ends

F. Remove bolts holding end bells (Figure 2)

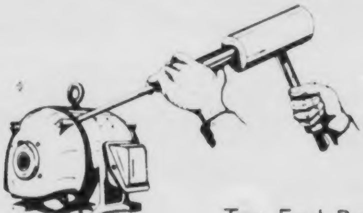
FIGURE 2



Remove Bolts

G. Use soft-faced mallet and screwdriver to tap end bells loose (Figure 3)

FIGURE 3



Tap End Bells Loose

H. Remove end bell that does not contain the starting switch or brush ring

(NOTE: Observe position and number of shims as you remove the rotor.)

I. Remove end bell containing starting switch

(CAUTION: Do not attempt to remove stator.)

JOB SHEET #1

J. Use very fine sandpaper to clean points

(CAUTION: Do not use emery cloth.)

K. Clean all parts of motor using special cleaning fluid

(NOTE: Do not get liquid on wires.)

L. Use tire pump or vacuum cleaner to dry parts

M. Clean bearings and make sure wicking is in place

N. Replace end bell containing switch

O. Insert rotor making sure shims are in place

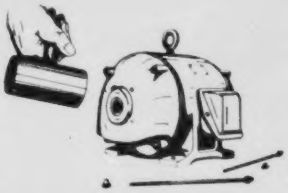
(NOTE: A drop of oil should be placed on bearing part of the shaft.)

P. Check position of end bells with center punch marks

(NOTE: Oil well should be up and window in bearing not in line of pull.)

Q. Use soft-faced hammer to tap bells in place (Figure 4)

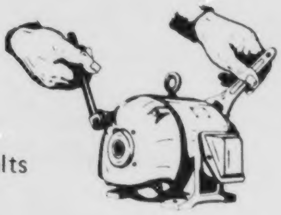
FIGURE 4



Tap Bells in Place

R. Insert end bell bolts and tighten (Figure 5)

FIGURE 5



Insert End Bolts

S. Turn shaft by hand

(NOTE: If it is tight, end bells may not be in proper alignment or the wicking may be between bearing and shaft.)

T. Connect temporary leads and test motor

ELECTRIC MOTORS
UNIT IV

TEST

NAME______________________________ SCORE__________________

1. Match terms associated with electric motors to the correct definitions. Place the appropriate numbers in the blanks provided.

_____a. Unit of mechanical power which is equal to 746 watts of electrical power

_____b. Revolutions per minute

_____c. Type of electrical service available to most farms; requires one transformer between power supplier and customer

_____d. Switch for reversing the direction of an electric motor

_____e. Cheapest electric motor available; used for easy starting loads

_____f. Most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads

_____g. Device capable of utilizing a sensing signal to open and close a (switch) circuit

_____h. Motor that has windings in the rotor and also has brushes and a commutator

_____i. Improper connection between hot and neutral wires or between hot wires

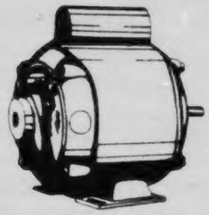
_____j. Motor that runs by induced current and does not have windings in the rotor

_____k. Motor that has a capacitor in the starting windings

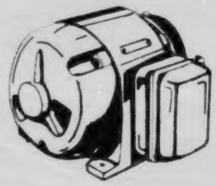
_____l. Switch, relay, and/or a contactor capable of responding to a device that senses variations in temperature, humidity, light, and pressure

1. Commutator
2. Relay
3. Automatic motor control
4. RPM
5. Three-phase motor
6. Short circuit
7. Horsepower (hp)
8. Capacitor-start motor
9. Repulsion-start motor
10. Induction-run motor
11. Split-phase motor
12. Single-phase

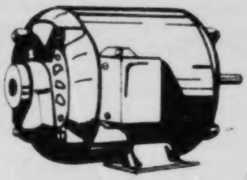
2. Identify the following types of A.C. single-phase, induction-run motors. Place the appropriate names in the blanks provided.



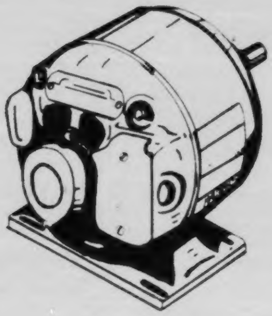
a.______________________________



b.______________________________



c.______________________________



d.______________________________

3. Classify the following types of A.C. single-phase, induction-run motors according to their characteristics. Place an "S" in front of those characteristics of a split-phase motor; an "R" for repulsion-start motors; a "C" for capacitor-start, capacitor-run; and an "RC" for repulsion-start, capacitor-run. A blank may have more than one answer.

______a. Cheapest electric motor available

______b. Used on hard-to-start loads

______c. Available in sizes of 1 to 15 hp

______d. Available in sizes of 5, 7 1/2, and 10 hp

______e. Uses 120-volt and/or 240-volt service

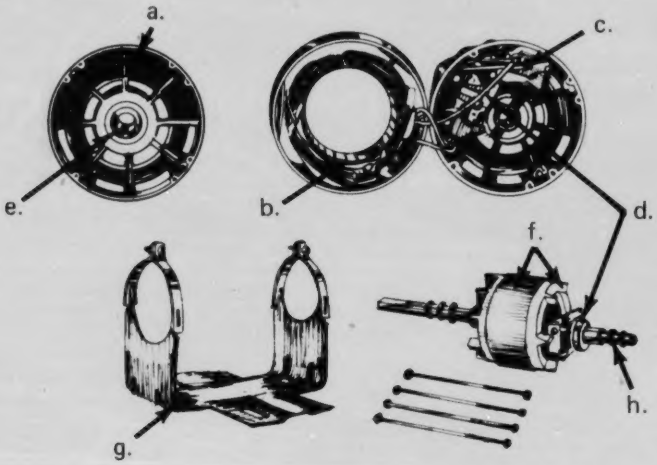
______f. Is a combination of capacitor-start, capacitor-run and repulsion-start

4. State the reason for the built-in capacitor in a capacitor-start motor.

____

____

5. Identify the parts of an induction-run motor. Write the appropriate names in the blanks below.



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

6. Name the requirements of an electric motor.

a. ______________________________

b. ______________________________

c. ______________________________

7. Name the factors to consider in selecting electric motors.

a. ______________________________

b. ______________________________

c. ______________________________

8. Discuss in a short paragraph the thumb rules to follow in estimating the size of an electric motor.

____

____

____

____

____

9. Complete the following chart on characteristics of electric motors.

MOTORS	STARTING ABILITY	STARTING CURRENT	STARTING MECHANISM	SPEED	VOLTAGE	COST & SIZE	APPLICATION
Split-Phase	Easy-to-start loads	Draws 6 to 8 times its normal running current	Two windings	Constant	____	Cheapest; 1/20 to 3/4 hp	____
Capacitor-Start, Induction-Run	____	Draws 3 to 6 times its full load	Two windings	Constant	____	25 to 40 percent more than the same size split-phase motor; 1/6 to 10 hp	Heavy duty farm use, such as air compressors, power tools, and feed grinders
Capacitor-Start, Capacitor-Run	Hard starting loads	Draws 3 to 5 times its normal running current	Has a running capacitor and a special slow starting mechanism	Constant 900 to 3600 rpm	____	20 percent more than capacitor-start, induction-run; 1/2 to 25 hp	____
Repulsion-Start, Induction-Run	____	Draws 3 times the running current	No starting winding but has two running windings	Constant 1200 to 1800 rpm	____	Similar to capacitor motors; 1/6 to 20 hp	Large general purpose farm use, such as feed mills, compressors, and silo unloaders
Universal	Easy starting		Brushes	Varies	____	Very economical; 1/20 to 1 hp	____
Shaded-Pole	Easy starting		Shaded windings, slow starting	Varies	____	Very economical; 1/20 to 1/4 hp	Small household fans, blowers, and hair dryers
Three-Phase	____	Can be designated as having low, normal, or high; 3 to 4 times the running current	Self-starting	Constant 400 to 3600 rpm	____	Expensive; 1/2 to many hundred hp	Used on loads requiring 10 hp or greater

10. Select from the list below factors to consider when replacing electric motors. Place an "X" in the appropriate blanks.

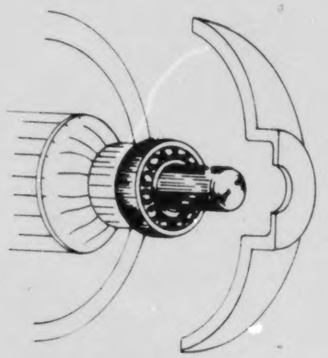
_____a. Type does not have to be the same

_____b. Voltage should be 120 and/or 240

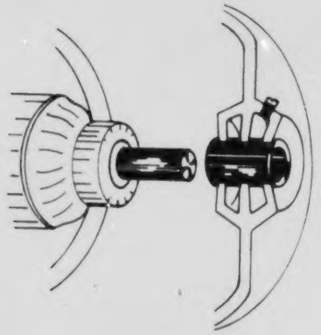
_____c. Full-load speed, cycles, duty, and base must be the same

_____d. Horsepower rating does not apply

11. Identify the following types of bearings used in electric motors. Place the appropriate names in the blanks provided.



a.____________________



b.____________________

12. Distinguish between types of bearings used in electric motors according to their characteristics. Place an "S" in front of the characteristics of a sleeve bearing and a "B" in front of those of a ball bearing.

_____a. No problem of oil loss

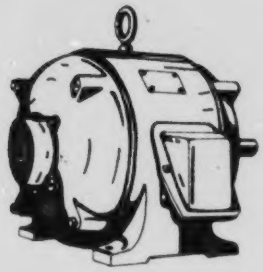
_____b. Installed in any position

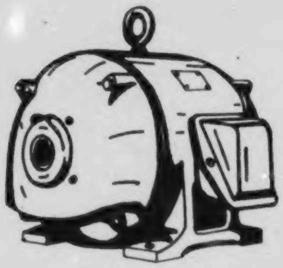
_____c. Oil-lubricated

_____d. Requires no greasing

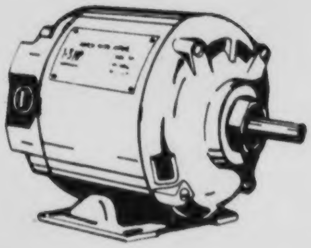
_____e. Shaft must be mounted parallel to the floor

13. Identify the following types of motor enclosures.





a.______________________________ b.______________________________



c.______________________________

14. Match the types of motor enclosures on the right to their uses on the left. Place the appropriate numbers in the blanks provided.

_____a. Used where dust and grit are a problem

_____b. Used on most farms where water is not being sprayed

_____c. Designed for either indoor or outdoor use, such as milk barns or irrigation pumps

_____d. Used around explosive materials, such as oil and gasoline

1. Open drip-proof
2. Splash-proof
3. Totally enclosed
4. Totally enclosed explosion-proof

15. Name two reasons for having protective devices on motors.

a. ______________________________

b. ______________________________

16. Name four causes of motor damage (burn-out).

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

17. Name five common motor enemies.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

18. Name four types of sensing devices used in switching electric motors.

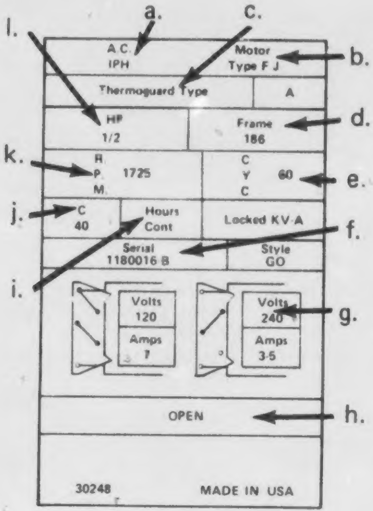
a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

19. Identify information found on the nameplate of a motor. Place the appropriate names in the blanks below.


a.
c.
l.
b.
d.
k.
e.
j.
f.
i.
g.
h.
A.C.
IPH
Motor
Type F J
Thermoguard Type
A
HP
1/2
Frame
186
R.
P.
M.
1725
C
Y
C
60
C
40
Hours
Cont
Locked KV-A
Serial
1180016-B
Style
GO
Volts
120
Amps
7
Volts
240
Amps
3-5
OPEN
30248
MADE IN USA

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

i. ______________________

____

j. ______________________

____

k. ______________________

l. ______________________

20. Demonstrate the ability to disassemble, clean, and reassemble an electric motor.

(NOTE: If the above activity has not been accomplished prior to the test, ask the instructor when it should be completed.)

ELECTRIC MOTORS
UNIT IV

ANSWERS TO TEST

1. Match terms associated with electric motors to the correct definitions. Place the appropriate numbers in the blanks provided.

__7__ a. Unit of mechanical power which is equal to 746 watts of electrical power

__4__ b. Revolutions per minute

__12__ c. Type of electrical service available to most farms; requires one transformer between power supplier and customer

__1__ d. Switch for reversing the direction of an electric motor

__11__ e. Cheapest electric motor available; used for easy starting loads

__5__ f. Most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads

__2__ g. Device capable of utilizing a sensing signal to open and close a (switch) circuit

__9__ h. Motor that has windings in the rotor and also has brushes and a commutator

__6__ i. Improper connection between hot and neutral wires or between hot wires

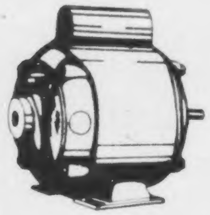
__10__ j. Motor that runs by induced current and does not have windings in the rotor

__8__ k. Motor that has a capacitor in the starting windings

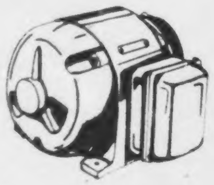
__3__ l. Switch, relay, and/or a contactor capable of responding to a device that senses variations in temperature, humidity, light, and pressure

1. Commutator
2. Relay
3. Automatic motor control
4. RPM
5. Three-phase motor
6. Short circuit
7. Horsepower (hp)
8. Capacitor-start motor
9. Repulsion-start motor
10. Induction-run motor
11. Split-phase motor
12. Single-phase

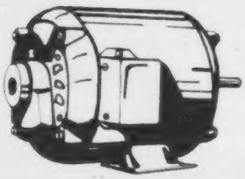
2. Identify the following types of A.C. single-phase, induction-run motors. Place the appropriate names in the blanks provided.



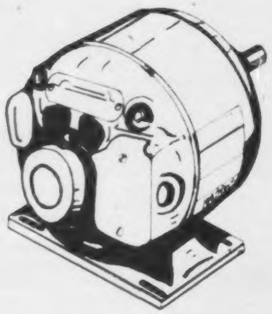
a. Capacitor-start, capacitor-run



b. Repulsion-start, capacitor-run



c. Repulsion-start



d. Split-phase

3. Classify the following types of A.C. single-phase, induction-run motors according to their characteristics. Place an "S" in front of those characteristics of a split-phase motor; an "R" for repulsion-start motors; a "C" for capacitor-start, capacitor-run; and an "RC" for repulsion-start, capacitor-run. A blank may have more than one answer.

S a. Cheapest electric motor available

R,C b. Used on hard-to-start loads

R C c. Available in sizes of 1 to 15 hp

C d. Available in sizes of 5, 7 1/2, and 10 hp

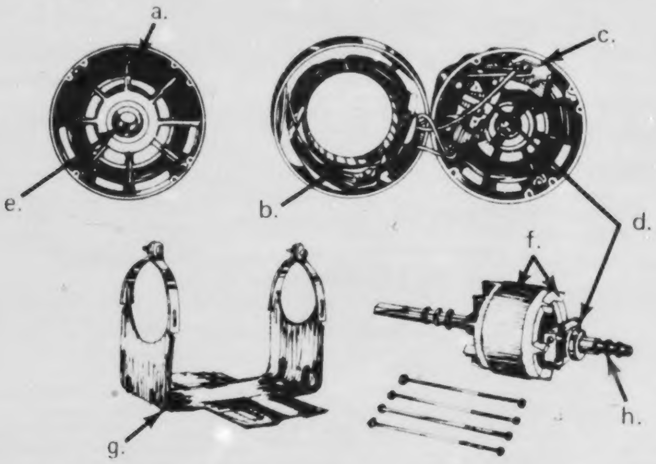
S,R e. Uses 120-volt and/or 240-volt service

R C f. Is a combination of capacitor-start, capacitor-run and repulsion-start

4. State the reason for the built-in capacitor in a capacitor-start motor.

Gives additional starting torque without requiring additional amperage

5. Identify the parts of an induction-run motor. Write the appropriate names in the blanks below.



a. Ventilated end bell or shield

b. Stator and frame

c. Thermal protection

d. Centrifugal starting switch

e. Sleeve bearing

f. Rotor and fans

g. Resilient mounting

h. Neoprene thrust washers

6. Name the requirements of an electric motor.

a. Must start the equipment load

b. Must drive the load once it is started

c. Must survive the abuse of the surroundings in which it operates

7. Name the factors to consider in selecting electric motors.

a. Type of electric power available

b. Type and size of load

c. Condition under which motor must operate

8. Discuss in a short paragraph the thumb rules to follow in estimating the size of an electric motor.

a. If equipment can be continuously operated by hand, a 1/4 hp electric motor will do the job

b. If a piece of equipment is driven satisfactorily by a gasoline engine, the engine can normally be replaced with an electric motor of about 2/3 to 3/4 as much horsepower as the engine

9. Complete the following chart on characteristics of electric motors.

MOTORS	STARTING ABILITY	STARTING CURRENT	STARTING MECHANISM	SPEED	VOLTAGE	COST & SIZE	APPLICATION
Split Phase	Easy to start loads	Draws 6 to 8 times its normal running current	Two windings	Constant	120 or 240	Cheapest; 1/20 to 3/4 hp	Light farm work; used on such tools as pumps, grinders, and fans
Capacitor Start, Induction Run	Fairly difficult starting loads	Draws 3 to 6 times its full load	Two windings	Constant	120 or 240	25 to 40 percent more than the same size split phase motor, 1/6 to 10 hp	Heavy duty farm use, such as air compressors, power tools, and feed grinders
Capacitor Start, Capacitor Run	Hard starting loads	Draws 3 to 5 times its normal running current	Has a running capacitor and a special slow starting mechanism	Constant 900 to 3600 rpm	120/240 under 2 hp 240 over 2 hp	20 percent more than capacitor start, induction run; 1/2 to 25 hp	General purpose farm use, such as pumps, blowers, and conveyors
Repulsion Start, Induction Run	Very heavy starting loads	Draws 3 times the running current	No starting winding but has two running windings	Constant 1200 to 1800 rpm	120 and 240	Similar to capacitor motors, 1/6 to 20 hp	Large general purpose farm use, such as feed mills, compressors, and silo unloaders
Universal	Easy starting		Brushes	Varies	120	Very economical; 1/20 to 1 hp	Shop tools, such as drills and saws
Shaded Pole	Easy starting		Shaded windings, slow starting	Varies	120	Very economical; 1/20 to 1/4 hp	Small household fans, blowers, and hair dryers
Three Phase	Variety of starting loads, usually for heavy, hard starting	Can be designated as having low, normal, or high, 3 to 4 times the running current	Self starting	Constant 400 to 3600 rpm	Voltage varies; used on large voltage	Expensive; 1/2 to many hundred hp	Used on loads requiring 10 hp or greater

10. Select from the list below factors to consider when replacing electric motors. Place an "X" in the appropriate blanks.

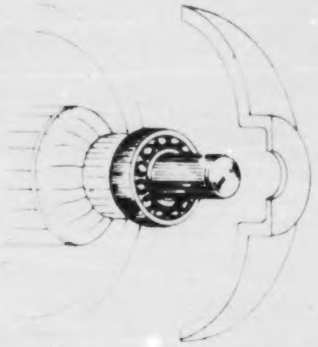
_____ a. Type does not have to be the same

__X__ b. Voltage should be 120 and/or 240

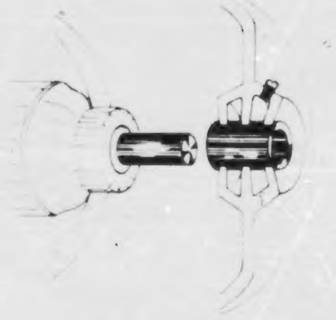
__X__ c. Full-load speed, cycles, duty, and base must be the same

_____ d. Horsepower rating does not apply

11. Identify the following types of bearings used in electric motors. Place the appropriate names in the blanks provided.



a. Ball



b. Sleeve

12. Distinguish between types of bearings used in electric motors according to their characteristics. Place an "S" in front of the characteristics of a sleeve bearing and a "B" in front of those of a ball bearing.

__B__ a. No problem of oil loss

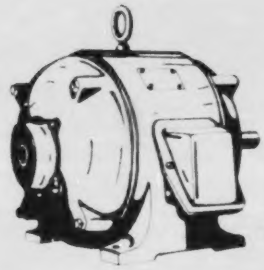
__B__ b. Installed in any position

__S__ c. Oil-lubricated

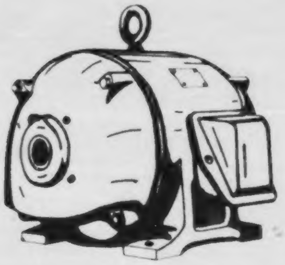
__B__ d. Requires no greasing

__S__ e. Shaft must be mounted parallel to the floor

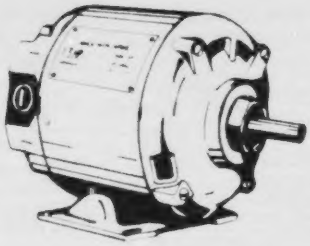
13. Identify the following types of motor enclosures.



a. Totally enclosed



b. Splash-proof



c. Open drip-proof

14. Match the types of motor enclosures on the right to their uses on the left. Place the appropriate numbers in the blanks provided.

__3__ a. Used where dust and grit are a problem

__1__ b. Used on most farms where water is not being sprayed

__2__ c. Designed for either indoor or outdoor use, such as milk barns or irrigation pumps

__4__ d. Used around explosive materials, such as oil and gasoline

1. Open drip-proof
2. Splash-proof
3. Totally enclosed
4. Totally enclosed explosion proof

15. Name two reasons for having protective devices on motors.

    (NOTE: Any two of the following are acceptable.)

    a. Protects against excessive overcurrent
    b. Prevents short circuits
    c. Prevents burning of windings
    d. Prevents overload

16. Name four causes of motor damage (burn-out)

    (NOTE: Any four of the following are acceptable.)

    a. Load too heavy
    b. Machine locked or jammed
    c. Belt too tight or too loose
    d. Bearings worn or needing lubrication
    e. Voltage lower than nameplate indication
    f. Motor and equipment pulley out of line

17. Name five common motor enemies.

    (NOTE: Any five of the following are acceptable.)

    a. Dust
    b. Stray oil
    c. Moisture
    d. Bearing friction
    e. Pulley misalignment
    f. Vibration
    g. Uneven wear
    h. Overload
    i. Inadequate wiring

18. Name four types of sensing devices used in switching electric motors.

(NOTE: Any four of the following are acceptable.)

a. Temperature

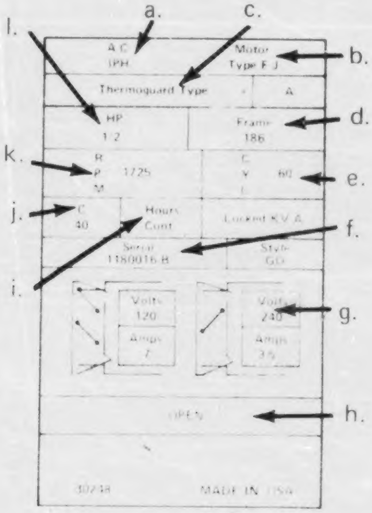
b. Humidity and moisture

c. Light

d. Pressure

e. Timing

19. Identify information found on the nameplate of a motor. Place the appropriate names in the blanks below.


a.
c.
l.
A C
1PH
Motor
Type F J
b.
Thermoguard Type
A
HP
1/2
Frame
186
d.
k.
R
P
M
1725
C
Y
C
60
e.
j.
C
40
Hours
Cont
Locked KVA
f.
Serial
1180016-B
Style
GO
i.
Volts
120
Amps
7
Volts
240
Amps
3.5
g.
OPEN
h.
30748
MADE IN USA

a. Type of current

b. Motor type

c. Type of overload protection

d. Type of frame

e. Cycle

f. Serial number

g. Volts

h. Type of enclosure

i. Hours that motor can be operated continuously

j. Temperature at which motor is to operate

k. RPM

l. Horsepower

20. Demonstrate the ability to disassemble, clean, and reassemble an electric motor.

(NOTE: Performance skills should be evaluated to the satisfaction of the instructor.)

BUILDING MATERIALS
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to select the proper siding and roofing materials and identify doors used on farm utility buildings. The student should be able to list characteristics of various types of building materials. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with building materials to the correct definitions.
2. Identify types of farm utility buildings.
3. List factors to consider when selecting roofing materials.
4. Select from a list types of roofing materials.
5. Complete a chart on characteristics and quality factors of roofing materials.
6. Identify types of roofing nails.
7. Classify types of roofing nails according to their characteristics.
8. Select from a list factors to consider when selecting siding material.
9. Complete a chart on characteristics and quality factors of types of siding.
10. Identify types of doors used on farm utility buildings.
11. Classify types of doors according to their characteristics.
12. Name ways to protect siding from decay or damage.
13. Complete a chart on paints and the types of surfaces on which they are used.
14. List characteristics to look for when selecting paint.

BUILDING MATERIALS
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and assignment sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Provide student actual experience in figuring amount of material for a building.

  G. Give test.

II. Unit references:

  A. *Farm Utility Building.* Athens, Georgia: American Association of Vocational Instructional Materials, 1972.

  B. Ahrens, Donald L. *Concrete and Concrete Masonary.* St. Paul, Minnesota: Hobar Publications, 1976.

  C. Wakeman, T. J., and McCoy, Vernon Lee. *The Farm Shop.* New York: The MacMillian Company, 1960.

  D. Phipps, Lloyd. *Mechanics in Agriculture.* Danville, Illinois: The Interstate Printers and Publishers, 1967.

  E. Cooper, George H., and Radzinski, Stanley Jr. *Building Construction Estimating.* 3rd ed. St. Louis, Missouri: McGraw-Hill Book Co., 1959.

BUILDING MATERIALS
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Utility building--Building designed to be used for a variety of purposes

      Examples: Vehicle and equipment storage, animal shelter, shop, service center

   B. Span--Distance from outside of top wall plate on one exterior wall to outside of top wall plate on opposite exterior wall

   C. Galvanized steel--Steel that has been coated with zinc

      Examples: Sheet roofing, nails, wire

   D. Square--Unit of measure designating materials that will cover 100 square feet

   E. Run--Horizontal distance from center of ridge board to outside of wall plate

   F. Pitch--Slant or slope of a roof

   G. Rise--Vertical distance from top of wall plate to top of ridge board

   H. Ridge board--Horizontal member at top of the roof to which the upper end of the rafters are attached

   I. Wall plate--Base on which lower end of rafter rests; usually across top of wall studs

II. Types of farm utility buildings (Transparencies 1 and 2)

   A. Shed roof

   B. Gable roof

   C. Gambrel roof

   D. Half arch

   E. Full arch

   F. Umbrella

   G. Pole barn

   (NOTE: Pole barns may come in a variety of roof types. The pictures of the shed roof, gable roof, and umbrella buildings are all examples of pole barns.)

INFORMATION SHEET

III. Factors to consider when selecting roofing materials

   A. Probable life expectancy due to weathering

   B. Fire resistance

   C. Hail resistance

   D. Resistance to heat and sun

   E. Resistance to strong wind

   F. Maintenance

   G. Minimum slope for application

   H. Weight

   I. Kinds of fasteners required

   J. Labor

   K. Cost

   L. Skill required for construction

IV. Types of roofing materials

   A. Galvanized steel

   B. Aluminum sheets

   C. Wood shingles

   D. Asphalt shingles

   E. Asphalt roll

   F. Asbestos-cement shingles

   G. Galvanized sheets

   H. Fiberglass sheets

   I. Steel sheets with baked on enamel

INFORMATION SHEET

V. Characteristics and quality factors of roofing materials

Roofing Materials				Probable life expectancy due to weathering		Fire resistance	Hail resistance	Resistance to heat from sun	Resistance to strong wind	Maintenance	Minimum roof slope with ordinary lap	Approximate wt. per sq. (100 sq. ft.) **	Corrosion resistance to salt and industrial fumes	Relative cost ***
				Years until first rust (approx.)	Probable life before roof rusts through *									
Galvanized Steel (all types)					(years)						(in. per ft.)	(lbs.)		
	Gage	Thickness (in.) ****	Wt. zinc coating (oz. per sq. ft.)											
	29	.0172 with coating	1.25 2.00	15 23	40 50+	Highly resistant	Good	Excellent If painted white is effective for reflecting heat	Good if well fastened	If painted with metallic zinc paint when rust starts to appear, life is increased	Corrugated 4 V-crimp 3	80 85	Poor	Low to Medium
	28	.0187	1.25	15	45									
	26	.0217	2.00	23	50+							100		
Aluminum Thickness generally available (inches) .019 .0215 .024 .032				50+ yrs.		Good	Fair with .019 inch unless used with solid decking. Good with heavier sheets	Excellent. Also excellent for heat reflection.	*Fair Good if well fastened	.019 inch punctures easily. Requires no painting. Sheets must be well nailed	4	29 36.5 55.2	Poor	Medium
Wood Shingles				8-30 yrs.		Burn readily	Good	Fair	Fair	May damage from strong winds	6	200	Good	High
Asphalt Shingles				7-25 yrs. Less durable in warmer regions		Will burn after heat builds up	Fair	Fair	Fair Good if well laid	May damage from strong winds or hail	5	250 to 300	Good	Low to Medium
Asphalt Roll Roofing Mineral surfaced, Selvage edge				About the same as asphalt shingles		Will burn	Fair	Fair	Fair	May damage from strong winds or hail	2- to 4-inch lap 4	100 to 140	Good	Low
Smooth surfaced				Much less than mineral surfaced shingles or selvage edge		Will burn	Fair	Fair	Fair	May damage from strong winds or hail	2- to 4-inch lap: 4	65	Good	Low
Asbestos-Cement Shingles and Corrugated sheets				50+ yrs.		Good	Good	Excel.	Good	May be damaged from flying objects	5 3	260 to 300 300	Good	Medium to High

*Test under farm conditions are not complete. Estimates were derived by projecting present rates of corrosion in rural areas and correlating the data with tests already completed under more corrosive conditions. Farms located near industrial areas, or near salt water, will get much less service. Painting with zinc paint when rust first appears will prolong the life of the steel.

**The different types of roofing vary in weight per square according to the thickness and density of the material.

***Cost for roofing material only. Costs will vary with the weights of roofing and also with the location in which it is purchased.

****Standard thicknesses specified by "United States Galvanized Sheet Gage." Sheets imported from other countries may come in under other gage standards that are not of the same thickness as the U. S. gage.

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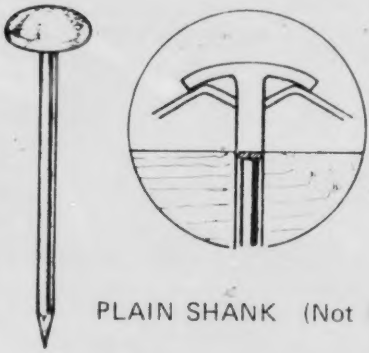
INFORMATION SHEET

VI. Types of roofing nails

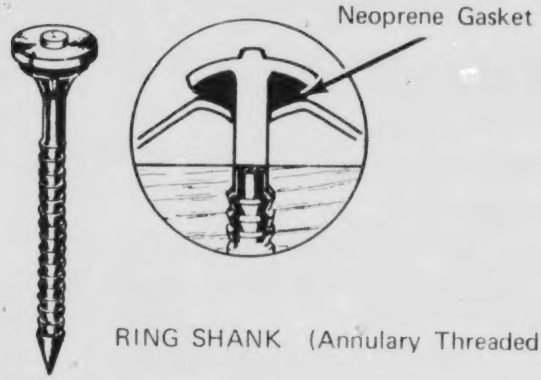
(NOTE: Nails come in a variety of heads for each type of shank.)

A. Plain shank



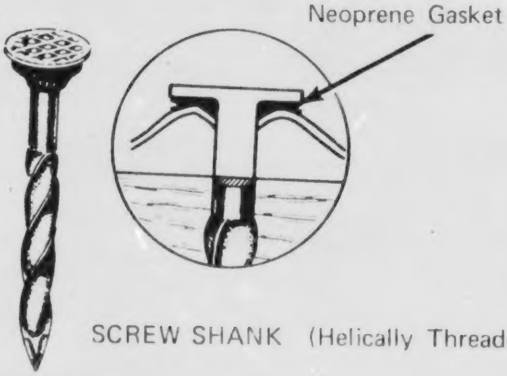
PLAIN SHANK (Not Recommended)

B. Ring shank


Neoprene Gasket

RING SHANK (Annulary Threaded)

C. Screw shank


Neoprene Gasket

SCREW SHANK (Helically Threaded)

INFORMATION SHEET

VII. Characteristics of roofing nails

A. Plain shank

1. Not recommended
2. Low holding power

B. Ring shank

1. High holding power
2. Comes in a variety of heads
3. Harder to drive

C. Screw shank

1. High holding power
2. Comes in a variety of heads
3. Easy to drive

(NOTE: Some finishes will have a chemical reaction with roofing material. Check recommendations for your local community.)

VIII. Factors to consider when selecting siding material

A. Life expectancy due to weathering

B. Fire resistance

C. Resistance to attack by vermin

D. Maintenance

E. Ability to be painted

F. Type of fastener needed

G. Cost

H. Ease of construction

INFORMATION SHEET

IX. Characteristics and quality factors of types of siding

Siding Materials	Probable Life Expectancy Due to Weathering	Fire Resistance	Resistance to Attack by Vermin	Maintenance	Paintability	Type Fastener Needed
Metals	40-50 yrs.	High	Not Affected	Low	Good with metallic zinc paint.	Galvanized steel with neopreme washer best. Flat head satisfactory.
Concrete blocks, 8-inch	50+ yrs.	High	Not Affected	Low	Good with paint, masonry.	
Wood siding, ¾-inch	50+ yrs.	Low	Subject to termites and rodents, unless treated with a wood preservative	Low for seasoned lumber, if properly protected from weather	Good with two coats of oil or latex paint.	Length: 2½" - 3". Flat head. Threaded or common. Galvanized steel, aluminum, stainless steel or silicon bronze.
Plywood, 3/8-inch (exterior grade)	Probably last indefinitely if kept painted. If unpainted durability will probably depend on thickness of face ply.	Low	Subject to termites and rodents, unless treated with a wood preservative	Low if properly protected from weather	Good with two coats of oil or latex paint.	Length: 1¾" - 3". Flat head. Threaded or common. Corrosion-resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.
Tempered hardboard, 5/16-inch (Fiberboard)*	Probably similar to plywood	Low	Subject to termites and rodents	Low if properly protected from weather	Good with oil paint	Length: 2". Flat head. Threaded or common. Corrosion-resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.

*Accepted as providing necessary rigidity when properly nailed to wood frame walls -- Building Code 1955.

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INFORMATION SHEET

X. Types of doors used on farm utility buildings (Transparency 3)

  A. Sliding

  B. Overhead

  C. Walk-thru

XI. Characteristics of types of doors

  A. Sliding

    1. Attaches to a track

    2. Can be made to fit any size opening

    3. Can be made of almost any type of material

  B. Overhead

    1. Commonly used on garages

    2. Mounted on track or guide

    3. Raised out of way when open

    4. Attractive

    5. More convenient to operate

    6. Costs more

    7. Locally available in limited number of sizes

  C. Walk-thru

    1. Most common for all buildings

    2. Small size

    3. Used primarily for human traffic

    4. Easy to install

    5. Ease in entering buildings

INFORMATION SHEET

XII. Ways to protect siding from decay or damage

A. Use treated lumber

B. Keep siding at least 6" above ground level

(NOTE: If additional protection is needed against termites or wetness, minimum height should be eighteen inches.)

C. Provide drainage away from all sides of the building

D. Provide eave troughs and down spouting to keep water from spilling on sides

E. Provide 8" to 20" of overhang on all sides of the building

F. Paint

XIII. Paints and the types of surfaces on which they are used

Type of Surface	Aluminum Paint	Cement Base Paint	Exterior Clear Finish	House Paint	Metal Roof Paint	Primer Or Undercoat	Rubber Base Paint	Spar Varnish	Transparent Sealer	Trim and Trellis Paint	Wood Stain
Wood											
Natural Finish			X					X			X
Shingle roof											X
Siding	X		X	X.		X					X
Windows	X			X.		X				X.	
Metal											
Copper						X		X			
Galvanized	X			X		X		X		X.	
Iron	X			X						X.	
Roof					X						
Siding	X			X						X	
Windows Aluminum	X			X						X	
Windows Steel	X			X						X	
Masonry											
Asbestos Cement				X.		X	X				
Brick	X	X		X		X	X		X		
Concrete Block	X	X		X		X	X		X		

*Black dot indicates that a primer or sealer may be necessary before the finishing coat, unless surface has been previously finished.

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INFORMATION SHEET

XIV. Characteristics to look for when selecting paint

A. Durability (4 to 8 years)

B. Self-cleaning (wears off gradually and keeps the surface relatively clean)

C. Highly reflective

D. Dirt resistant

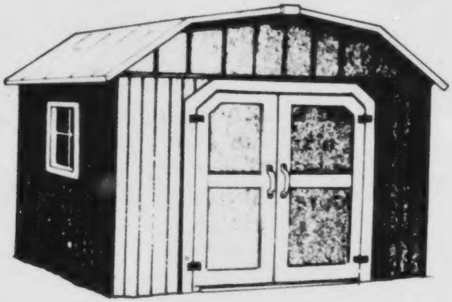
E. Nonsensitive to moisture (resistant to blistering and peeling)

F. Resistant to rain and discoloration

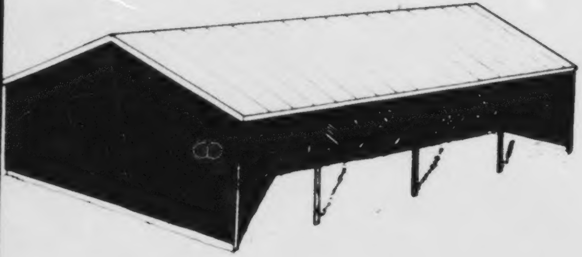
G. Good hiding or covering qualities

H. Use

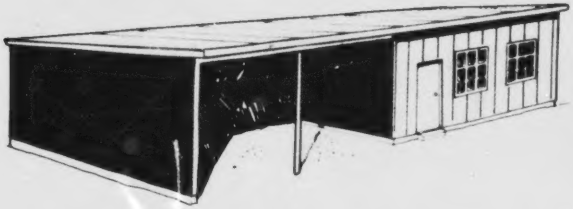
Types Of Farm Utility Buildings



Gambrel-Roof



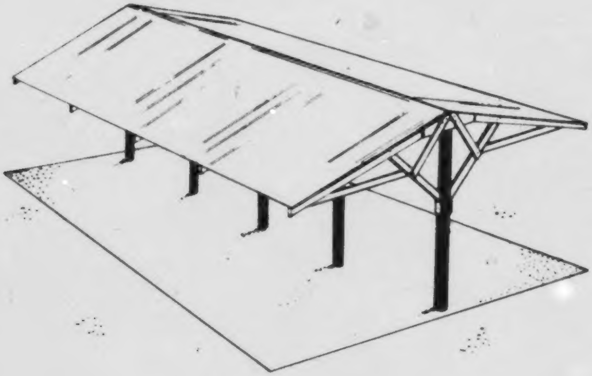
Gable-Roof



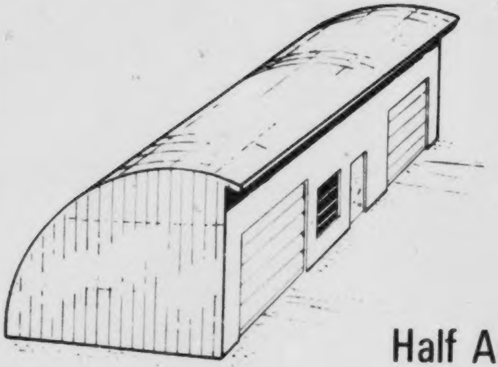
Shed-Roof

Types Of Farm Utility Buildings

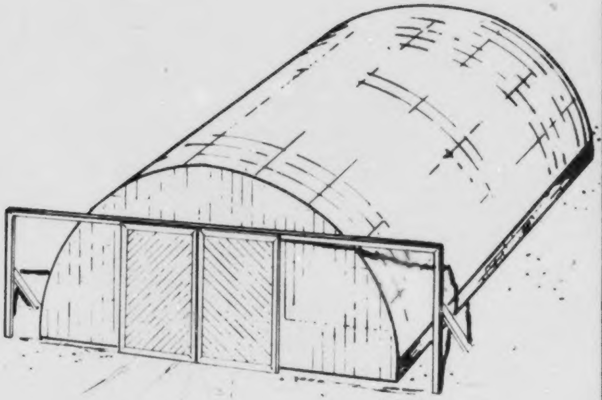
(Continued)



Umbrella

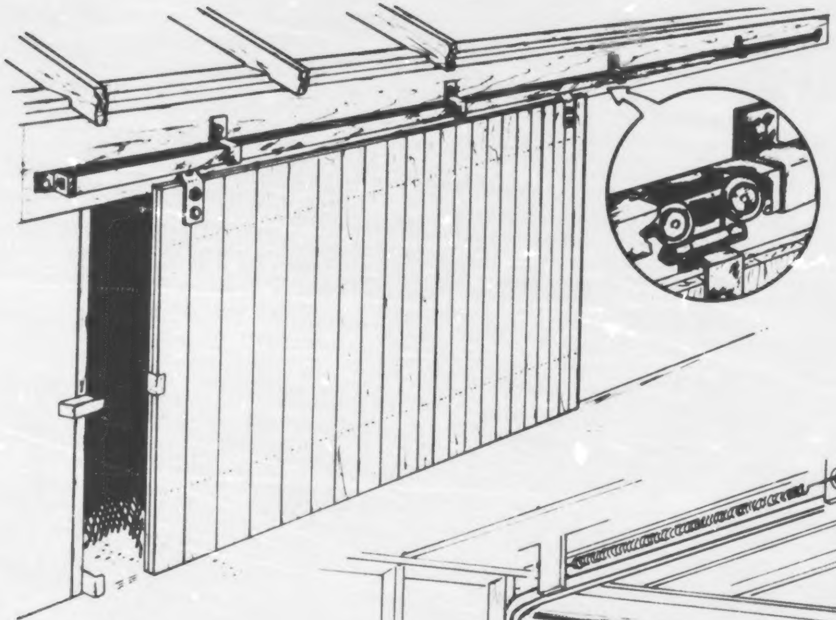


Half Arch

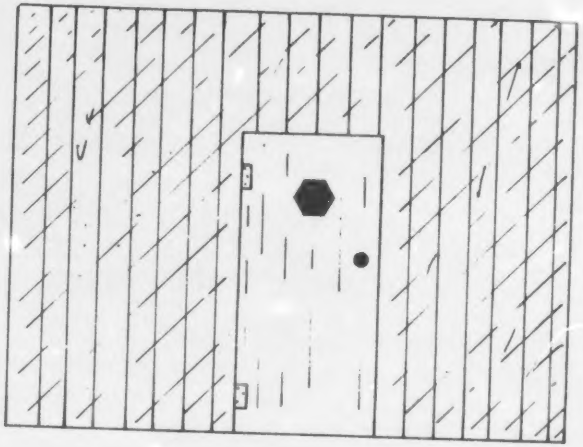


Full Arch

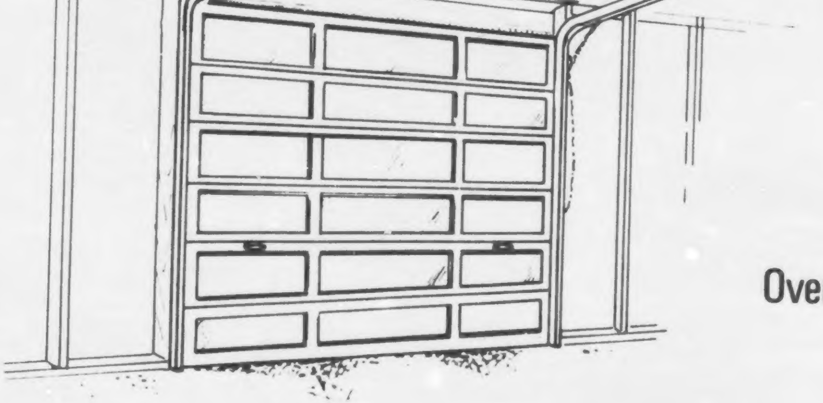
Types Of Doors For Utility Buildings



Sliding Door



Walk-Thru Door



Overhead Door

BUILDING MATERIALS
UNIT I

TEST

NAME ______________________ SCORE ______________

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

_____a. Vertical distance from top of wall plate to top of ridge board

_____b. Horizontal distance from center of ridge board to outside of wall plate

_____c. Unit of measure designating materials that will cover 100 square feet

_____d. Distance from outside of top wall plate on one exterior wall to outside of top wall plate on opposite exterior wall

_____e. Building designed to be used for a variety of purposes

_____f. Steel that has been coated with zinc

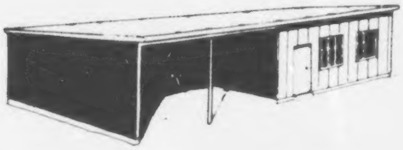
_____g. Base on which lower end of rafter rests; usually across top of wall studs

_____h. Horizontal member at top of the roof to which the upper end of the rafters are attached

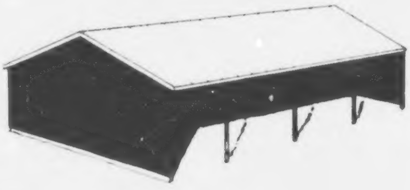
_____i. Slant or slope of a roof

1. Square
2. Galvanized steel
3. Span
4. Rise
5. Utility building
6. Run
7. Ridge board
8. Wall plate
9. Pitch

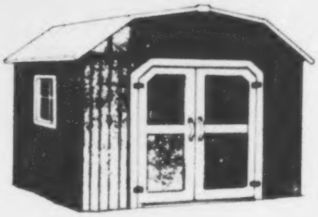
2. Identify the following types of farm utility buildings by writing the correct names in the blanks provided.



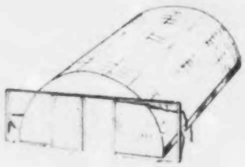
a. ______________________



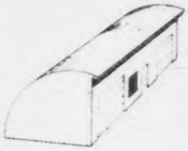
b. ______________________



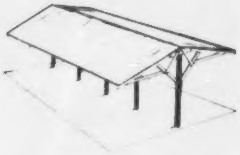
c. ______________________________



d. ______________________________



e. ______________________________



f. ______________________________

3. List five factors to consider when selecting roofing materials.

a. ____

b. ____

c. ____

d. ____

e. ____

4. Select from the list below types of roofing materials by placing an "X" in the appropriate blanks.

______a. Galvanized steel

______b. Plywood

______c. Aluminum sheets

______d. Wood shingles

______e. Asphalt shingles

______f. Asphalt roll

______g. Asbestos-cement shingles

______h. Galvanized sheets

______i. Fiberglass sheets

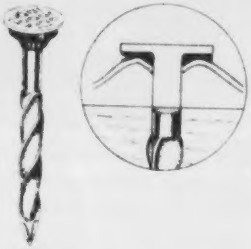
______j. Rough fencing

______k. Glass

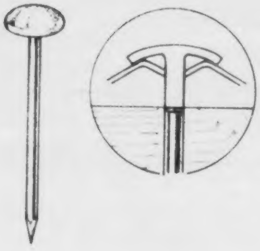
5. Complete the following chart on characteristics and quality factors of roofing materials.

Roofing Materials			**Probable life expectancy due to weathering**		**Fire resistance**	**Hail resistance**	**Resistance to heat from sun**	**Resistance to strong wind**	**Maintenance**	**Minimum roof slope with ordinary lap**	**Approximate wt. per sq. (100 sq. ft.) ****	**Corrosion resistance to salt and industrial fumes**	**Relative cost *****
			Years until first rust (approx.)	**Probable life before roof rusts through ***									
Galvanized Steel (all types)				(years)						(in. per ft.)	(lbs.)		
Gage	Thickness (in.) ****	Wt. zinc coating (oz. per sq. ft.)											
29	.0172 with coating	1.25	15	____	Highly resistant	Good	Excellent. If painted white is effective for reflecting heat.	____	If painted with metallic zinc paint when rust starts to appear, life is increased.	Corrugated 4 V-crimp 3	80	____	Low to Medium
		2.00	23	____									
28	.0187	1.25	15	____							85		
26	.0217	2.00	23	____							100		
Aluminum Thickness generally available (inches) .019 .0215 .024 .032			50+ yrs.		Good	Fair with .019 inch unless used with solid decking. Good with heavier sheets.	Excellent. Also excellent for heat reflection	Fair. Good if well fastened	.019 inch punctures easily. Requires no painting. Sheets must be well nailed.	4	29 36.5 55.2	Poor	Medium
Wood Shingles			8-30 yrs.		Burn readily	Good	____	Fair	May damage from strong winds.	6	200	____	High
Asphalt Shingles			7-25 yrs. Less durable in warmer regions		Will burn after heat builds up	____	Fair	____	May damage from strong winds or hail	5	250 to 300	____	Low to Medium
Asphalt Roll Roofing Mineral-surfaced, Selvage edge			About the same as asphalt shingles.		Will burn	Fair	____	Fair	May damage from strong winds or hail	2 to 4 inch lap 4	100 to 140	____	Low
Smooth-surfaced			Much less than mineral surfaced shingles or selvage edge		Will burn	____	Fair	Fair	May damage from strong winds or hail	2 to 4 inch lap 4	65	____	Low
Asbestos-Cement Shingles and Corrugated sheets			____		Good	Good	____	____	May be damaged from flying objects	5 3	260 to 300 300	____	Medium to High

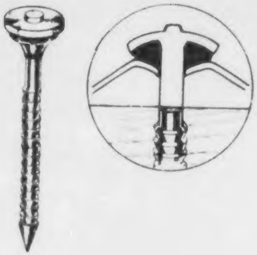
6. Identify the following types of roofing nails by writing the correct names in the blanks provided.



a. ____________________



b. ____________________



c. ____________________

7. Classify types of roofing nails according to their characteristics. Place an "S" in front of the characteristics of the screw shank, an "R" in front of those of a ring shank, and a "P" in front of plain shank. A blank may have more than one correct answer.

______a. High holding power

______b. Not recommended

______c. Comes in a variety of heads

______d. Low holding power

______e. Harder to drive

______f. Easy to drive

8. Select from the list below factors to consider when selecting siding materials by placing an "X" in the blanks provided.

______a. Life expentancy due to weathering

______b. Fire resistance

______c. Maintenance

______d. Ability to be painted

______e. Type of fastener needed

______f. Cost

______g. Location

______h. Distance from supplier

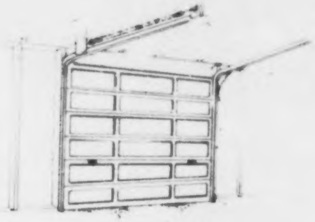
______i. Ease of construction

9. Complete the chart below on characteristics and quality factors of types of siding.

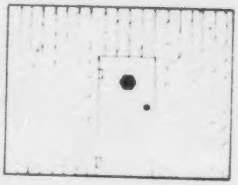
Siding Materials	**Probable Life Expectancy Due to Weathering**	**Fire Resistance**	**Resistance to Attack by Vermin**	**Maintenance**	**Paintability**	**Type Fastener Needed**
Metals	____________	High	Not Affected	____________	____________	____________
Concrete blocks, 8-inch	50+ yrs.	High	Not Affected	____________	Good with paint, masonry.	
Wood siding, ¾-inch	____________	____________	Subject to termites and rodents, unless treated with a wood preservative	Low for seasoned lumber, if properly protected from weather (Note text)	Good with two coats of oil or latex paint.	Length: 2½" - 3". Flat head. Threaded or common. Galvanized steel, aluminum, stainless steel or silicon bronze.
Plywood, 3/8-inch (exterior grade)	Probably last indefinitely if kept painted. If unpainted durability will probably depend on thickness of face ply.	Low	Subject to termites and rodents, unless treated with a wood preservative	Low if properly protected from weather	Good with two coats of oil or latex paint.	Length: 1¾" - 3". Flat head. Threaded or common. Corrosion-resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.
Tempered hardboard, 5/16-inch (Fiberboard)*	Probably similar to plywood	____________	Subject to termites and rodents	Low if properly protected from weather	Good with oil paint	Length: 2". Flat head. Threaded or common. Corrosion resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.

*Accepted as providing necessary rigidity when properly nailed to wood frame walls -- Building Code 1955.

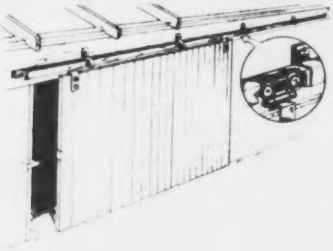
10. Identify the following types of doors used on farm utility buildings by writing the correct names in the blanks provided.



a. ______________________



b. ______________________



c. ______________________

11. Classify types of doors according to their characteristics. Place an "S" in front of the characteristics of a sliding door, an "O" in front of those of an overhead door, and a "W" in front of those of a walk-thru door.

______a. Attaches to a track

______b. Attractive

______c. Can be made of almost any type of material

______d. Most common for all buildings

______e. Raised out of way when open

______f. Easy to install

______g. Can be made to fit any size opening

______h. More convenient to operate

______i. Costs more

______j. Used primarily for human traffic

______k. Locally available in limited number of sizes

12. Name three ways to protect siding from decay or damage.

a. ______________________________

b. ______________________________

c. ______________________________

13. Complete the following chart on paints and the types of surfaces on which they are used.

Type of Surface	Aluminum Paint	Cement Base Paint	Exterior Clear Finish	House Paint	Metal Roof Paint	Primer Or Undercoat	Rubber Base Paint	Spar Varnish	Transparent Sealer	Trim and Trellis Paint	Wood Stain
Wood											
Natural Finish			X					X			X
Shingle roof											X
Siding			X								X
Windows										X.	
Metal											
Copper								X			
Galvanized								X		X.	
Iron										X.	
Roof					X.						
Siding										X.	
Windows-Aluminum										X	
Windows-Steel										X	
Masonry											
Asbestos Cement							X				
Brick		X					X		X		
Concrete Block		X					X		X		

*Black dot indicates that a primer or sealer may be necessary before the finishing coat, unless surface has been previously finished.

14. List three characteristics to look for when selecting paint.

a. ______________________________

b. ______________________________

c. ______________________________

BUILDING MATERIALS
UNIT I

ANSWERS TO TEST

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

__4__ a. Vertical distance from top of wall plate to top of ridge board

__6__ b. Horizontal distance from center of ridge board to outside of wall plate

__1__ c. Unit of measure designating materials that will cover 100 square feet

__3__ d. Distance from outside of top wall plate on one exterior wall to outside of top wall plate on opposite exterior wall

__5__ e. Building designed to be used for a variety of purposes

__2__ f. Steel that has been coated with zinc

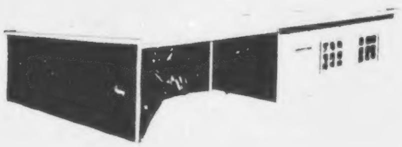
__8__ g. Base on which lower end of rafter rests; usually across top of wall studs

__7__ h. Horizontal member at top of the roof to which the upper end of the rafters are attached

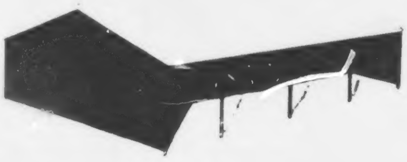
__9__ i. Slant or slope of a roof

1. Square
2. Galvanized steel
3. Span
4. Rise
5. Utility building
6. Run
7. Ridge board
8. Wall plate
9. Pitch

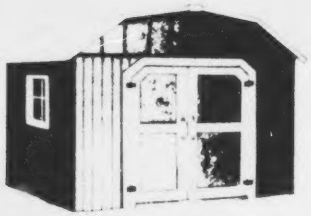
2. Identify the following types of farm utility buildings by writing the correct names in the blanks provided.



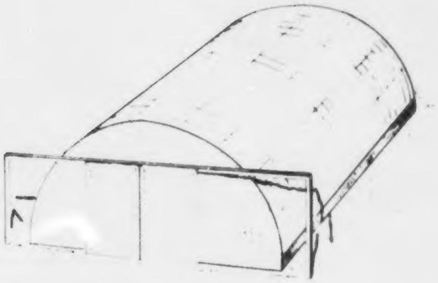
a. Shed roof



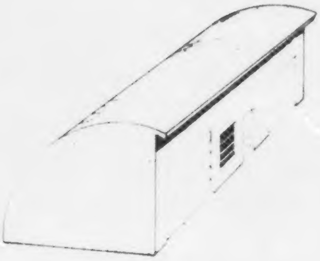
b. Gable roof



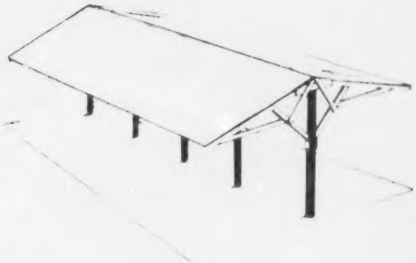
c. Gambrel-roof



d. Full arch



e. Half arch



f. Umbrella

3. List five factors to consider when selecting roofing materials.

(NOTE: Any five of the following are acceptable.)

a. Probable life expectancy due to weathering

b. Fire resistance

c. Hail resistance

d. Resistance to heat and sun

e. Resistance to strong wind

f. Maintenance

g. Minimum slope for application

h. Weight

i. Kinds of fasteners required

j. Labor

k. Cost

l. Skill required for construction

Select from the list below types of roofing materials by placing an "X" in the appropriate blanks.

__X__ a. Galvanized steel

_____ b. Plywood

__X__ c. Aluminum sheets

__X__ d. Wood shingles

__X__ e. Asphalt shingles

__X__ f. Asphalt roll

__X__ g. Asbestos-cement shingles

__X__ h. Galvanized sheets

_____ i. Fiberglass sheets

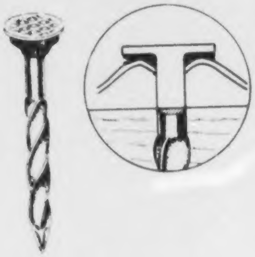
_____ j. Rough fencing

_____ k. Glass

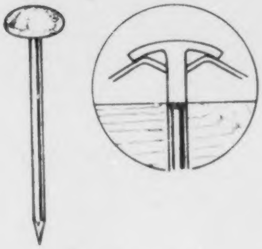
5. Complete the following chart on characteristics and quality factors of roofing materials.

Roofing Materials				Probable life expectancy due to weathering		Fire resistance	Hail resistance	Resistance to heat from sun	Resistance to strong wind	Maintenance	Minimum roof slope with ordinary lap	Approximate wt. per sq. (100 sq. ft.) **	Corrosion resistance to salt and industrial fumes	Relative cost ***
				Years until first rust (approx.)	Probable life before roof rusts through *									
Galvanized Steel (all types)					(years)						(in. per ft.)	(lbs.)		
Gage	Thickness (in.) ****	Wt. zinc coating (oz. per sq. ft.)												
29	.0172 with coating	1.25		15	40	Highly resistant	Good	Excellent. If painted white is effective for reflecting heat.	Good if well fastened.	If painted with metallic zinc paint when rust starts to appear, life is increased.	Corrugated: 4	80	Poor	Low to Medium
		2.00		23	50+						V-crimp: 3	85		
28	.0187	1.25		15	45									
26	.0217	2.00		23	50+							100		
Aluminum Thickness generally available (inches) .019 .0215 .024 .032				50+ yrs.		Good	Fair with .019 inch unless used with solid decking. Good with heavier sheets.	Excellent. Also excellent for heat reflection.	Fair. Good if well fastened.	.019 inch punctures easily. Requires no painting. Sheets must be well nailed.	4	29 36.5 55.2	Poor	Medium
Wood Shingles				8-30 yrs.		Burn readily	Good	Fair	Fair	May damage from strong winds.	6	200	Good	High
Asphalt Shingles				7-25 yrs. Less durable in warmer regions		Will burn after heat builds up.	Fair	Fair	Fair. Good if well laid.	May damage from strong winds or hail.	5	250 to 300	Good	Low to Medium
Asphalt Roll Roofing: Mineral-surfaced, Selvage edge				About the same as asphalt shingles		Will burn	Fair	Fair	Fair	May damage from strong winds or hail.	2- to 4-inch lap 4	100 to 140	Good	Low
Smooth surfaced				Much less than mineral surfaced shingles or selvage edge		Will burn	Fair	Fair	Fair	May damage from strong winds or hail.	2- to 4-inch lap 4	65	Good	Low
Asbestos-Cement Shingles and Corrugated sheets				50+ yrs.		Good	Good	Excel.	Good	May be damaged from flying objects.	5 3	260 to 300 300	Good	Medium to High

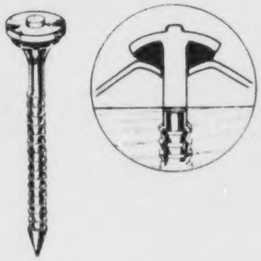
6. Identify the following types of roofing nails by writing the correct names in the blanks provided.



a. Screw shank



b. Plain shank



c. Ring shank

7. Classify types of roofing nails according to their characteristics. Place an "S" in front of the characteristics of the screw shank, an "R" in front of those of a ring shank, and a "P" in front of plain shank. A blank may have more than one correct answer.

S,R a. High holding power

P b. Not recommended

S, R c. Comes in a variety of heads

P d. Low holding power

R e. Harder to drive

S f. Easy to drive

8. Select from the list below factors to consider when selecting siding materials by placing an "X" in the blanks provided.

X a. Life expectancy due to weathering

X b. Fire resistance

X c. Maintenance

X d. Ability to be painted

X e. Type of fastener needed

X f. Cost

______ g. Location

______ h. Distance from supplier

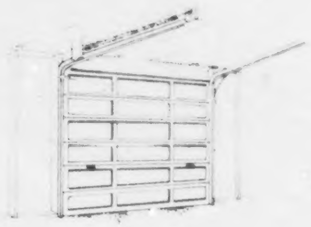
X i. Ease of construction

9. Complete the chart below on characteristics and quality factors of types of siding.

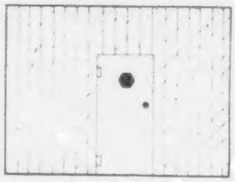
Siding Materials	**Probable Life Expectancy Due to Weathering**	**Fire Resistance**	**Resistance to Attack by Vermin**	**Maintenance**	**Paintability**	**Type Fastener Needed**
Metals	40-50 yrs.	High	Not Affected	Low	Good with metallic zinc paint.	Galvanized steel with neopreme washer best. Flat head satisfactory.
Concrete blocks, 8-inch	50+ yrs.	High	Not Affected	Low	Good with paint, masonry.	
Wood siding, ¼-inch	50+ yrs.	Low	Subject to termites and rodents, unless treated with a wood preservative	Low for seasoned lumber, if properly protected from weather (Note text)	Good with two coats of oil or latex paint.	Length: 2½" - 3". Flat head. Threaded or common. Galvanized steel, aluminum, stainless steel or silicon bronze.
Plywood, 3/8-inch (exterior grade)	Probably last indefinitely if kept painted. If unpainted durability will probably depend on thickness of face ply.	Low	Subject to termites and rodents, unless treated with a wood preservative	Low if properly protected from weather	Good with two coats of oil or latex paint.	Length: 1¾" - 3" Flat head. Threaded or common. Corrosion-resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.
Tempered hardboard, 5/16-inch (Fiberboard)*	Probably similar to plywood	Low	Subject to termites and rodents	Low if properly protected from weather	Good with oil paint	Length: 2". Flat head. Threaded or common. Corrosion-resistant material: galvanized steel, aluminum, stainless steel or silicon bronze.

*Accepted as providing necessary rigidity when properly nailed to wood frame walls -- Building Code 1955.

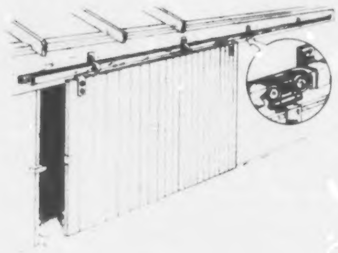
10. Identify the following types of doors used on farm utility buildings by writing the correct names in the blanks provided.



a. Overhead



b. Walk-thru



c. Sliding

11. Classify types of doors according to their characteristics. Place an "S" in front of the characteristics of a sliding door, an "O" in front of those of an overhead door, and a "W" in front of those of a walk-thru door.

__S__ a. Attaches to a track

__O__ b. Attractive

__S__ c. Can be made of almost any type of material

__W__ d. Most common for all buildings

__O__ e. Raised out of way when open

__W__ f. Easy to install

__S__ g. Can be made to fit any size opening

__O__ h. More convenient to operate

__O__ i. Costs more

__W__ j. Used primarily for human traffic

__O__ k. Locally available in limited number of sizes

12. Name three ways to protect siding from decay or damage.

(NOTE: Any three of the following are acceptable.)

a. Use treated lumber

b. Keep siding at least 6" above ground level

c. Provide drainage away from all sides of the building

d. Provide eave troughs and down spouting to keep water from spilling on sides

e. Provide 8" to 20" of overhang on all sides of the building

f. Paint

13. Complete the following chart on paints and the types of surfaces on which they are used.

Type of Surface	Aluminum Paint	Cement Base Paint	Exterior Clear Finish	House Paint	Metal Roof Paint	Primer Or Undercoat	Rubber Base Paint	Spar Varnish	Transparent Sealer	Trim and Trellis Paint	Wood Stain
Wood											
Natural Finish			X					X			X
Shingle roof											X
Siding	X		X	X.		X			.		X
Windows	X			X.		X				X.	
Metal											
Copper						X		X			
Galvanized	X.*			X.		X		X		X.	
Iron	X.			X.						X.	
Roof					X.						
Siding	X.			X.						X.	
Windows-Aluminum	X			X.						X	
Windows-Steel	X.			X.						X	
Masonry											
Asbestos Cement				X.		X	X				
Brick	X	X		X.		X	X		X		
Concrete Block	X	X		X.		X	X		X		

*Black dot indicates that a primer or sealer may be necessary before the finishing coat, unless surface has been previously finished

14. List three characteristics to look for when selecting paint.

(NOTE: Any three of the following are acceptable.)

a. Durability (4 to 8 years)

b. Self-cleaning (wears off gradually and keeps the surface relatively clean)

c. Highly reflective

d. Dirt resistant

e. Nonsensitive to moisture (resistant to blistering and peeling)

f. Resistant to rain and discoloration

g. Good hiding or covering qualities

h. Use

BILLS OF MATERIALS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to complete bills of materials for various projects. The student should also be able to calculate problems in determining board feet and costs of various materials. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with bills of materials to the correct definitions.
2. Match the units of measure by which various materials are sold to the correct materials.
3. Select from a list basic measurements in width and length by which most lumber is sold.
4. Identify the components of a bill of materials.
5. Match symbols used in lumber selection to the correct descriptions.
6. Calculate board feet.
7. Calculate cost of materials.
8. Complete a bill of materials.
9. Determine cost of a project.
10. Estimate building materials.

BILLS OF MATERIALS
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparency.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Require each student to complete a bill of materials for each project constructed in the shop.

   G. Give test.

II. Unit references:

   A. Jones, Mack M. *Shopwork on the Farm.* New York: McGraw-Hill Book Company, 1955.

   B. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook*. Danville, Illinois: Interstate Publishers and Printers.

   C. *Steel Reference Book*. Standard Steel Company, 1400 E. Reno, Oklahoma City, Oklahoma.

   D. Wakeman, T. J., and McCoy, Vernon Lee. *The Farm Shop.* New York: The MacMillan Company, 1960.

BILLS OF MATERIALS
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Bill of materials--Itemized list of the number and kind of pieces needed and the dimensions of each for the construction of a project

B. Board foot--Piece of lumber one inch thick, 12 inches long, and 12 inches wide

C. Running foot--Foot length of a material regardless of thickness and width

D. Square foot--Equal to a 12-inch by 12-inch surface regardless of thickness

E. Cubic foot--Measurement 12 inches long by 12 inches wide by 12 inches thick

F. Square--Unit of measurement equal to 100 square feet of material

G. Surfaced lumber--Lumber that has been surfaced by running through a planer

H. Rough stock--Lumber that has been sawed to dimension but not planed; usually thicker and wider

I. Planer--Machine that smoothes the surface of rough lumber

J. Gauge--Unit of measure for thickness of metal

(NOTE: Gauge has no relation to thickness in inches up to 10 gauge, then it becomes plate.)

II. Units of measure for various materials

A. Board foot--Lumber

B. Running foot--Molding, some steel rods, chain, cable

C. Square foot--Some steel products

(NOTE: Steel priced by the square foot generally is calculated from weight per square foot.)

D. Square--Metal siding, roofing sheet iron, shingles

E. Bundle--Lathe, sometimes shingles when a square is broken

(NOTE: Four bundles of standard 16-inch wood shingles make a square. Three bundles of asphalt shingles make a square.)

INFORMATION SHEET

F. Weight--Steel

(NOTE: Practically all metals are priced per pound.)

G. Sheet--Plywood, fiberboard, 4' X 8' sheets

(NOTE: Corrugated steel siding or roofing comes in various lengths and 26" wide. Figure width 2" less than actual.)

III. Basic measurements of lumber in width and length

(NOTE: Most standard steels come in 20' or 40' lengths.)

A. Width

	Rough	Actual
1.	4 inches	3 1/2 inches
2.	6 inches	5 1/2 inches
3.	8 inches	7 1/2 inches
4.	10 inches	9 1/2 inches
5.	12 inches	11 1/2 inches

B. Length

(NOTE: Lengths of sheet siding are comparable.)

1. 6 feet
2. 8 feet
3. 10 feet
4. 12 feet
5. 14 feet
6. 16 feet

IV. Components of a bill of materials (Transparency 1)

A. Date

B. Name and address of seller

C. Name of purchaser

(NOTE: Many times a person will secure material and charge the material to employer.)

INFORMATION SHEET

D. Project or job

E. Number of pieces

F. Kind of material

G. Dimensions

H. Unit cost per kind of material

I. Total cost

J. By whom received

K. Terms

(NOTE: Most firms have paper pads or order books used for completing a bill of materials.)

V. Symbols used in lumber selection

A. S1S--Surfaced on one side

B. S2S--Surfaced on two sides

C. S1E--Surfaced on one edge

D. S2E--Surfaced on t[illegible]dges

E. S4S--Surfaced on all four sides

VI. Formula for calculating board feet (Assignment Sheet #1)

$$\frac{\text{No. of pieces X thickness in inches X width in inches X length in feet}}{12}$$

Example: One board 1" thick X 4" wide X 12' long

$$\frac{1 \text{ X } 1'' \text{ X } 4'' \text{ X } 12'}{12} = 4 \text{ board feet}$$

VII. Calculation of cost of various materials (Assignment Sheet #2)

A. Lumber--Board feet

1. Figure number of board feet

INFORMATION SHEET

2. Multiply number of board feet by cost per board foot

   Example:

   1-2" X 8" X 12 at $.30/bd ft or $300/M (1000 bd ft)

   $$\frac{1 \text{ X } 2'' \text{ X } 8'' \text{ X } 12'}{12} = 16 \text{ board feet}$$

   16 board feet X $.30 = $4.80

B. Steel

1. Figure number of square feet to be covered
2. Determine weight of steel
3. Multiply total weight by price per pound

   Example:

   (NOTE: Sixteen gauge sheet steel weighs 2.5 lbs/sq ft and is $.30/lb.)

   3' X 8' = 24 sq ft

   24 sq ft X 2.5 lbs = 60 lbs

   60 lbs X $.30 = $18.00

C. Sheet iron roofing

1. Figure number of square feet to be covered
2. Calculate number of square feet per sheet
3. Determine number of sheets needed

   (NOTE: Sheet iron roofing generally overlaps 2". Standard width will be 26".)

   Example:

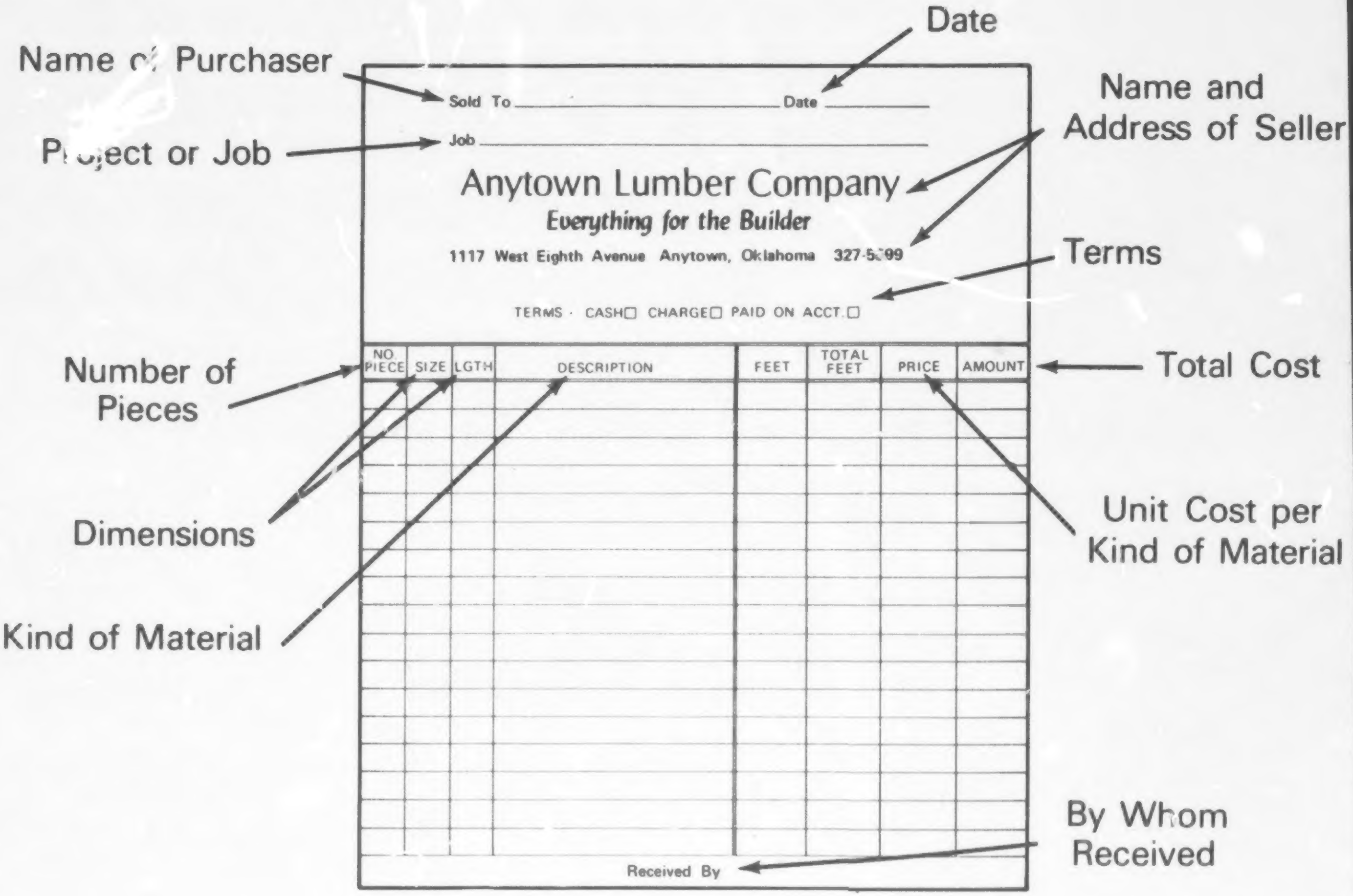
   (NOTE: Roof for shed is 8' wide by 10' long. Sheet roofing is 2' wide and 10' long.)

   8' X 10' = 80 sq ft

   2' X 10' = 20 sq ft per sheet

   80 sq ft ÷ 20 sq ft = 4 sheets

Components of a Bill of Materials


Date
Name of Purchaser
Name and Address of Seller
Project or Job
Terms
Number of Pieces
Total Cost
Dimensions
Unit Cost per Kind of Material
Kind of Material
By Whom Received

Sold To ____________________ Date __________

Job ______________________________

Anytown Lumber Company

Everything for the Builder

1117 West Eighth Avenue Anytown, Oklahoma 327-5[illegible]99

TERMS · CASH☐ CHARGE☐ PAID ON ACCT.☐

NO. PIECE	SIZE	LGTH	DESCRIPTION	FEET	TOTAL FEET	PRICE	AMOUNT

Received By

BILLS OF MATERIALS
UNIT II

ASSIGNMENT SHEET #1--CALCULATE BOARD FEET

Calculate the total board feet in each of the problems listed below.

Formula:

$$\frac{\text{No. of pieces X thickness in inches X width in inches X length in feet}}{12}$$

1. 1 piece 1" X 10" X 10' =

2. 1 piece 1" X 4" X 14' =

3. 1 piece 2" X 6" X 8' =

4. 1 piece 2" X 8" X 10' =

5. 2 pieces 2" X 4" X 8' =

6. 5 pieces 1" X 8" X 8' =

7. 10 pieces 4" X 6" X 10' =

8. 1 piece 2" X 4" X 18' =

BILLS OF MATERIALS
UNIT II

ASSIGNMENT SHEET #2--CALCULATE COST OF MATERIALS

Calculate the cost of the various materials listed below.

1. Lumber--Number of Board Feet X Cost per Board Foot = Cost of Lumber

   a. 4 pieces 2" X 10" X 12' at a cost of $275/M

   b. 22 pieces 2" X 4" X 16' at a cost of #.32/bd ft

   c. 12 pieces 1" X 12" X 12' at a cost of $.27/bd ft

2. Steel--Pounds X Price per Pound = Cost of Material

   (NOTE: Use the tables on the following pages to determine weight of metals for the problems below.)

   a. Find the cost of 5 pieces of hot rolled sheet steel 18 ga 3' X 8' at $.27 per pound.

   b. Determine the cost of 100 pieces of 1" X 1" X 1/4" angle iron 20' long at a cost of $.25 per pound.

ASSIGNMENT SHEET #2

c. Find the cost of 10 pieces of 1/2" round stock 10' long at a cost of $.32 per pound.

d. Calculate the cost of 5 pieces of 5/8" concrete reinforcing bars 20 ft long at a cost of $.07 per foot.

e. Calculate the cost of one piece of 3" channel iron 10 ft long that weighs 5 lb per foot at a cost of $.30 per pound.

ASSIGNMENT SHEET #2

CONCRETE REINFORCING BARS

BAR SIZES Old (Inches)	BAR SIZES New (Numbers)	Weight Pounds Per Ft.	Diameter Inches
¼	2	.167	.250
⅜	3	.376	.375
½	4	.668	.500
⅝	5	1.043	.625
¾	6	1.502	.750
⅞	7	2.044	.875
1	8	2.670	1.000
1	9	3.400	1.128
1⅛	10	4.303	1.270
1¼	11	5.313	1.410

ROUNDS

Size in Inches	Weight Per Ft.	Size in Inches	Weight Per Ft.
¼	0.167	2¼	13.52
5/16	0.261	2⅜	15.06
⅜	0.376	2½	16.69
7/16	0.511	2⅝	18.40
½	0.668	2¾	20.20
9/16	0.845	3	24.02
⅝	1.043	3¼	28.21
¾	1.502	3½	32.71
⅞	2.044	3¾	37.55
1	2.670	4	42.73
1⅛	3.379	4¼	48.23
1¼	4.173	4½	54.08
1⅜	5.05	4¾	60.25
1½	6.01	5	66.76
1⅝	7.051	5¼	73.60
1¾	8.18	5½	80.78
1⅞	9.39	5¾	88.29
2	10.68	6	96.13
2⅛	12.06		

CHANNELS—STRUCTURAL

Depth of Channel Inches	Weight Per Ft., Lbs.	Thickness of Web	Width Flange Inches
3	4.1	0.170	1.410
	5.0	0.258	1.498
	6.0	0.356	1.596
4	5.4	0.180	1.580
	7.25	0.320	1.720
5	6.7	0.190	1.750
	9.0	0.325	1.885
6	8.2	0.200	1.920
	10.5	0.314	2.034
	13.0	0.437	2.157
7	9.8	0.210	2.090
	12.25	0.314	2.194
	14.75	0.419	2.299
8	11.5	0.220	2.260
	13.75	0.303	2.343
	18.75	0.487	2.527
9	13.4	0.230	2.430
	15.0	0.285	2.485
	20.0	0.448	2.648
10	15.3	0.240	2.600
	20.0	0.379	2.739
	25.0	0.526	2.886
	30.0	0.673	3.033
12	20.7	0.280	2.940
	25.0	0.287	3.047
	30.0	0.510	3.170
13	31.8	0.375	4.000
	50.0	0.787	4.412
15	33.9	0.400	3.400
	40.0	0.520	3.520
	50.0	0.716	3.716
18	45.8	0.700	4.000

ASSIGNMENT SHEET #2

ANGLES—BAR SIZES

Size in Inches	Weight Per Ft., Lbs.
1 x1 x⅛	.80
3/16	1.16
¼	1.49
1⅛x1⅛x⅛	.90
1¼x1¼x⅛	1.01
3/16	1.48
¼	1.92
1⅜x ⅞x⅛	.91
3/16	1.32
1½x1¼x3/16	1.64
1½x1½x⅛	1.23
3/16	1.80
¼	2.34
1¾x1¼x⅛	1.23
1¾x1¾x⅛	1.44
3/16	2.12
¼	2.77
2 x1¼x3/16	1.96
¼	2.55

Size in Inches	Weight Per Ft., Lbs.
2 x1½x⅛	1.44
3/16	2.12
¼	2.77
2 x2 x⅛	1.65
3/16	2.44
¼	3.19
5/16	3.92
⅜	4.70
2¼x1½x3/16	2.28
2½x1½x3/16	2.44
¼	3.19
5/16	3.92
2½x2 x3/16	2.75
¼	3.62
5/16	4.50
⅜	5.30
2½x2½x3/16	3.07
¼	4.10
5/16	5.00
⅜	5.90
½	7.70

ANGLES—STRUCTURAL

Size in Inches	Weight Per Ft., Lbs.
3 x2 x3/16	3.07
¼	4.10
5/16	5.00
⅜	5.90
½	7.70
3 x2½x¼	4.50
5/16	5.60
⅜	6.60
½	8.50
3½x3 x¼	5.40
5/16	6.60
⅜	7.90
½	10.20
3½x3½x¼	5.80
5/16	7.20
⅜	8.50
7/16	9.80
½	11.10
4 x3 x¼	5.80
5/16	7.20
⅜	8.50
7/16	9.80
½	11.10
⅝	13.60
4 x3½x¼	6.2
5/16	7.7
⅜	9.1
7/16	10.6
½	11.9
4 x4 x¼	6.6
5/16	8.2
⅜	9.8
7/16	11.3
½	12.8
⅝	15.7
¾	18.5
5 x3 x¼	6.6
5/16	8.2
⅜	9.8
7/16	11.3
½	12.8
5 x3½x[illegible]	8.7
⅜	10.4
7/16	12.0
½	13.6
⅝	16.8
¾	19.8

Size in Inches	Weight Per Ft., Lbs.
3 x3 x3/16	3.71
¼	4.90
5/16	6.10
⅜	7.20
7/16	8.30
½	9.40
3½x2½x¼	4.90
5/16	6.10
⅜	7.20
½	9.40
5 x5 x⅜	12.3
½	16.2
⅝	20.0
¾	23.6
6 x3½x5/16	9.8
⅜	11.7
½	15.3
6 x4 x5/16	10.3
⅜	12.3
7/16	14.3
½	16.2
⅝	20.0
¾	23.6
⅞	27.2
6 x6 x⅜	14.9
7/16	17.2
½	19.6
⅝	24.2
¾	28.7
⅞	33.1
1	37.4
7 x4 x⅜	13.6
½	17.9
⅝	22.1
8 x4 x½	19.6
8 x6 x½	23.0
⅝	28.5
¾	33.8
1	44.2
8 x8 x½	26.4
⅝	32.7
¾	38.9
⅞	45.0
1	51.0

ASSIGNMENT SHEET #2

HOT ROLLED SHEET STEEL

Commercial Quality Prime Open Hearth Low Carbon

(Manufacturers Standard Gage)

Gage and Size in Inches	Est. Wt. per Sheet
No. 7 (3/16")	
Wt. per Sq. Ft. 7.50	
36 x 96	180.0
36 x 120	225.0
36 x 144	270.0
36 x 240	450.0
42 x 96	210.0
42 x 120	262.5
42 x 144	315.0
42 x 240	525.0
48 x 96	240.0
48 x 120	300.0
48 x 144	360.0
48 x 240	600.0
60 x 96	300.0
60 x 120	375.0
60 x 144	450.0
60 x 240	750.0
72 x 96	336.0
72 x 126	420.0
72 x 144	504.0
72 x 240	840.0
Over 72" See Plates	
No. 8 (.1644")	
Wt. per Sq. Ft. 6.875	
36 x 96	165.0
36 x 120	206.3
36 x 144	247.5
36 x 192	330.0
42 x 96	192.5
42 x 120	240.6
42 x 144	288.8
42 x 192	385.0
48 x 96	220.0
48 x 120	275.0
48 x 144	333.0
48 x 192	440.0
54 x 96	247.5
54 x 120	309.4
54 x 144	371.3
54 x 192	495.0
No. 8 (.1644") (Cont'd.)	
60 x 96	275.0
60 x 120	343.8
60 x 144	412.5
60 x 192	550.0
72 x 96	330.0
72 x 120	412.5
72 x 144	495.0
72 x 192	660.0
No. 10 (.1345")	
Wt. per Sq. Ft. 5.625	
36 x 96	135.0
36 x 108	151.9
36 x 120	168.8
36 x 144	202.5
40 x 96	150.0
40 x 120	187.5
42 x 96	157.5
42 x 120	196.9
42 x 144	236.3
48 x 96	180.0
48 x 120	225.0
48 x 144	270.0
54 x 96	202.5
54 x 120	253.1
60 x 96	225.0
60 x 120	281.3
60 x 144	337.5
72 x 96	270.0
72 x 120	337.5
72 x 144	405.0
72 x 192	540.0
No. 11 (.1196")	
Wt. per Sq. Ft. 5.00	
36 x 96	120.0
36 x 120	150.0
36 x 144	180.0
42 x 96	140.0
42 x 120	175.0
42 x 144	210.0
48 x 96	160.0
48 x 120	200.0
48 x 144	240.0
54 x 144	270.0
No. 11 (.1196")(Cont'd.)	
Wt. per Sq. Ft. 5.00	
60 x 96	200.0
60 x 120	250.0
60 x 144	300.0
72 x 120	300.0
72 x 144	360.0
72 x 192	480.0
No. 12 (.1046")	
Wt. per Sq. Ft. 4.375	
36 x 96	105.0
36 x 120	131.3
36 x 144	157.5
40 x 96	116.7
40 x 120	145.8
42 x 96	122.5
42 x 120	153.1
42 x 144	183.8
48 x 96	140.0
48 x 120	175.0
48 x 144	210.0
48 x 156	227.5
54 x 96	157.5
54 x 120	196.9
54 x 192	315.0
60 x 96	175.0
60 x 120	218.8
60 x 144	262.5
60 x 168	306.3
72 x 96	210.0
72 x 120	262.5
72 x 144	315.0
72 x 192	420.0
No. 14 (.0747")	
Wt. per Sq. Ft. 3.125	
36 x 96	75.0
36 x 120	93.8
36 x 144	112.5
40 x 96	83.3
40 x 120	104.2
42 x 96	87.5
42 x 120	109.4
42 x 144	131.3
No. 14 (.0747") (Cont'd.)	
48 x 96	100.0
48 x 120	125.0
48 x 144	150.0
48 x 156	162.5
54 x 96	112.5
54 x 120	140.6
54 x 156	182.8
60 x 96	125.0
60 x 120	156.3
60 x 144	187.5
60 x 192	250.0
72 x 96	150.0
72 x 120	187.5
72 x 144	225.0
No. 16 (.0598")	
Wt. per Sq. Ft. 2.50	
36 x 96	60.0
36 x 120	75.0
36 x 144	90.0
40 x 96	66.7
40 x 120	83.3
42 x 96	70.0
42 x 120	87.5
42 x 144	105.0
48 x 96	80.0
48 x 120	100.0
48 x 144	120.0
48 x 156	130.0
54 x 96	90.0
54 x 120	112.5
54 x 156	146.3
60 x 96	100.0
60 x 120	125.0
60 x 144	150.0
60 x 168	175.0
No. 18 (.0478")	
Wt. per Sq. Ft. 2.00	
36 x 96	48.0
36 x 120	60.0
42 x 96	56.0
42 x 120	70.0
48 x 96	64.0
48 x 120	80.0
48 x 144	96.0

AgM - 57-E

BILLS OF MATERIALS
UNIT II

ASSIGNMENT SHEET #3--COMPLETE A BILL OF MATERIALS

Complete a bill of materials for a project you are to make in the shop or a project designated by the instructor. Use the form below.

Sold To ______________________ Date __________

Job ____________________________________

Anytown Lumber Company

Everything for the Builder

1117 West Eighth Avenue Anytown, Oklahoma 327-5599

TERMS - CASH☐ CHARGE☐ PAID ON ACCT.☐

NO. PIECE	SIZE	LGTH	DESCRIPTION	FEET	TOTAL FEET	PRICE	AMOUNT

Received By

BILLS OF MATERIALS
UNIT II

ASSIGNMENT SHEET #4--DETERMINE COST OF A PROJECT

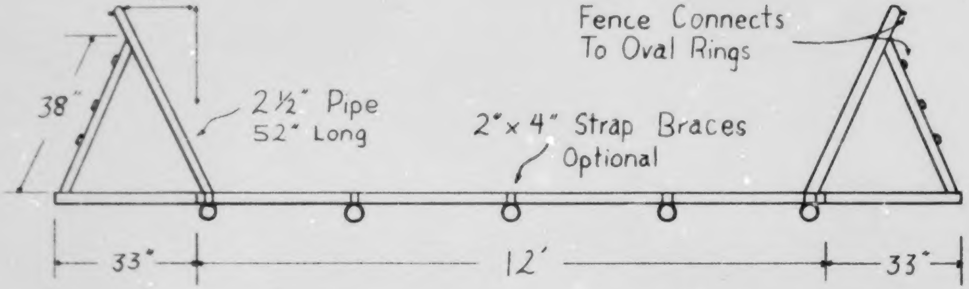
Using the following drawings, complete the cost of material for the two projects listed below. Use current prices. Call the local dealer and get all prices needed.

Cattle Guard	Price
4" pipe	
2 1/2" pipe	
Strap metal	
Rings (rod)	

3-Point Hoist	Price
2" double strength pipe	
1" pipe	
3/4" rod	
Steel plate, 1/4"	
Steel plate, 3/4"	

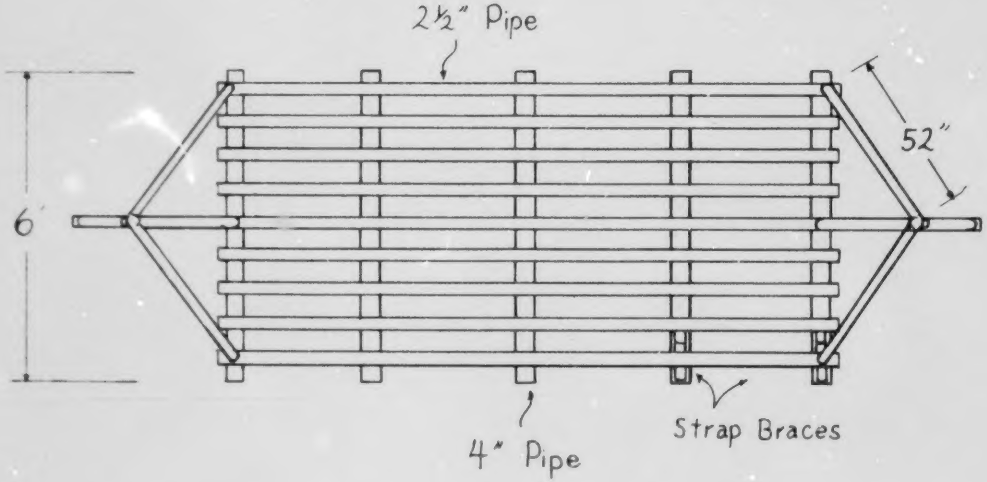
Cattle Guard

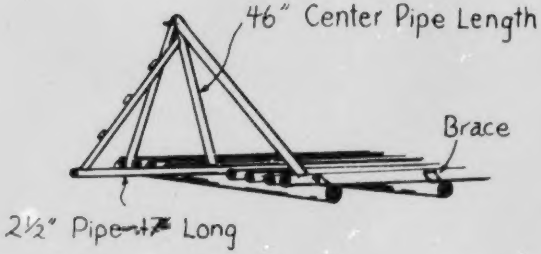
Scale: 1/2"=1'


16"
38"
2½" Pipe
52" Long
Fence Connects
To Oval Rings
2"x 4" Strap Braces
Optional
33"
12'
33"

BILL OF MATERIAL

5 Pieces of 4" Pipe 72" Long
8 Pieces of 2½" Pipe 12' Long
1 Piece of 2½" Pipe 17' Long
4 Pieces of 2½" Pipe 52" Long
2 Pieces of 2½" Pipe 47" Long
2 Pieces of 2½" Pipe 38" Long
20 Pieces of 2" x 4" Strap Metal
70 Pieces of 1½" x 3" Strap Metal
8 Pieces of Oval Shaped Rings


2½" Pipe
52"
6'
4" Pipe
Strap Braces


46" Center Pipe Length
Brace
2½" Pipe ~~47~~ Long

Pictorial View of One End

Curriculum and Instructional Materials Center
State Department of Vocational and Technical Education
Stillwater, Oklahoma

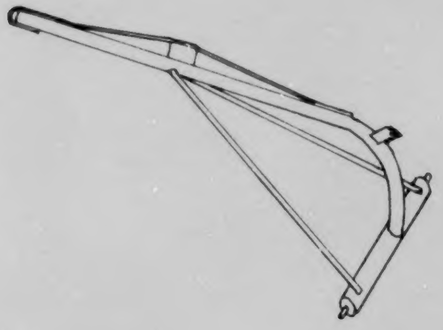
Courtesy of [illegible]
Vocational Agriculture Department

Rea

05:7

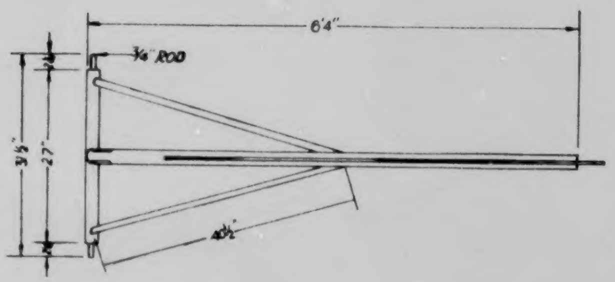
3-Point Hoist

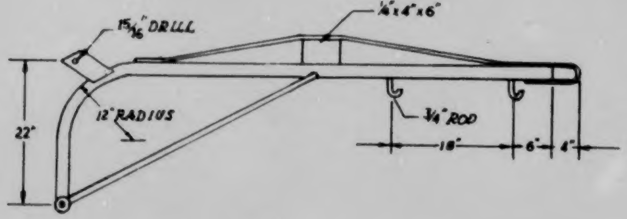
Scale: ¾" = 1'



BILL OF MATERIAL

1 PIECE OF 2" DOUBLE STRENGTH PIPE 98" LONG
1 PIECE OF 2" DOUBLE STRENGTH PIPE 27" LONG
1 PIECE OF 1" PIPE FOR BRACES 40 ½" LONG
1 PIECE OF ¾" ROD FOR TOP BRACE 6'7" LONG
1 PIECE OF STEEL PLATE ¼" x 4" x 6"
2 PIECES OF STEEL PLATE ¾" x 3" x 6"
2 PIECES OF ¾" ROD FOR BOTTOM HOOKS 7" LONG
1 PIECE OF ¾" ROD 31 ½" LONG





Courtesy of Keota
Vocational Agriculture Department

Curriculum and Instructional Materials Center
State Department of Vocational and Technical Education
Stillwater, Oklahoma

DWN BY: JOHN McEACHERN

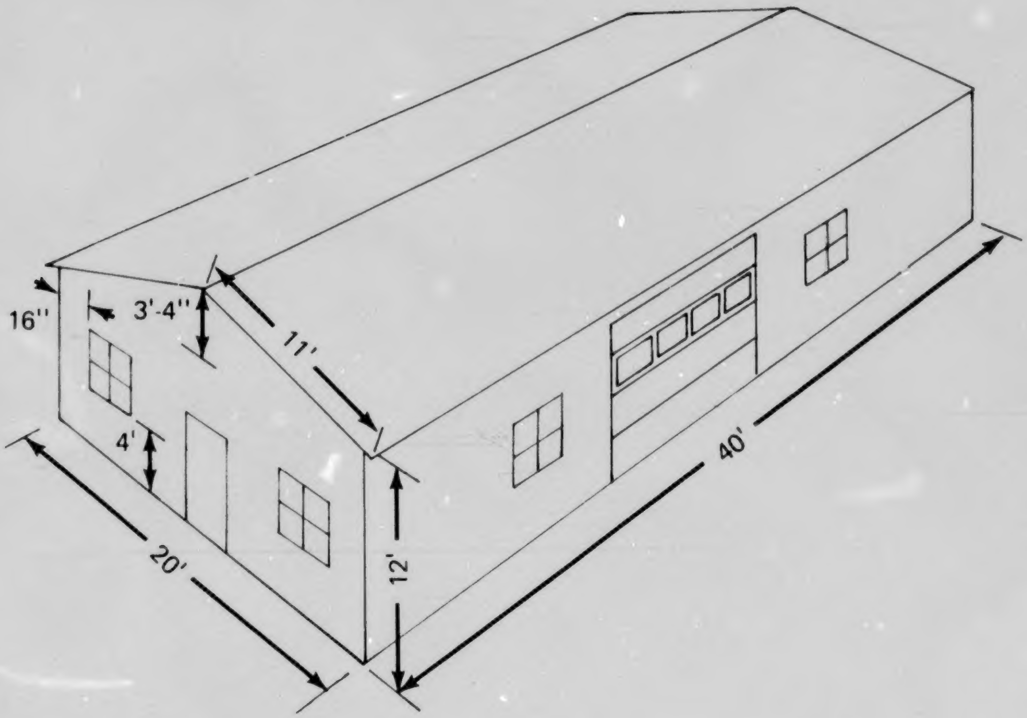
AgM - 61-E

BILLS OF MATERIALS
UNIT II

ASSIGNMENT SHEET #5--ESTIMATE BUILDING MATERIALS

Use the following drawing and estimate the squares of corrugated galvanized sheets it will take to cover the entire building minus the openings. Add 5% for waste. A square will cover 100 square feet of area.

Area = L X W



Door: 7' x 3.5' (opening size)

Windows: 2.5' x 3' (frame size)

Overhead Door: 10' x 10' (opening size)

There are 2 windows on side not shown but none on end not shown.

BILLS OF MATERIALS
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 8.3 board feet
2. 4.7 board feet
3. 8 board feet
4. 13.3 board feet
5. 10.7 board feet
6. 26.7 board feet
7. 200 board feet
8. 12 board feet

Assignment Sheet #2

1. a. $22.00
   b. $75.09
   c. $38.88
2. a. $64.80
   b. $745.00
   c. $21.38
   d. $7.00
   e. $15.00

Assignment Sheet #3--Evaluated to the satisfaction of the instructor

Assignment Sheet #4--Evaluated to the satisfaction of the instructor

Assignment Sheet #5

Roof

11' X 40' X 2 = 880 sq ft

Side

40' X 12' - 2(2.5' X 3') = 465 sq ft
40' X 12' - 2(2.5' X 3') + 10' X 10' = 365 sq ft

Ends

20' X 12' - 2(2.5' X 3') + 7.0' X 3.5' = 200.5 sq ft

$\frac{20' \times 3.33' \times 2}{2}$ = 66.6 sq ft

20' X 12' 240 sq ft

2217.1 sq ft

5% for waste 111.0 sq ft

2328.1 sq ft

$\frac{2328.1 \text{ sq ft}}{100 \text{ sq ft}}$ = 23.281 squares of sheet iron

BILLS OF MATERIALS
UNIT II

TEST

NAME ______________________________ SCORE __________________

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

_____a. Piece of lumber one inch thick, 12 inches long, and 12 inches wide

_____b. Foot length of a material regardless of thickness and width

_____c. Equal to a 12-inch by 12-inch surface regardless of thickness

_____d. Unit of measurement equal to 100 square feet of material

_____e. Lumber that has been sawed to dimension but not planed; usually thicker and wider

_____f. Lumber that has been surfaced by running through a planer

_____g. Measurement 12 inches long by 12 inches wide by 12 inches thick

_____h. Itemized list of the number and kind of pieces needed and the dimensions of each for the construction of a project

_____i. Machine that smoothes the surface of rough lumber

_____j. Unit of measure for thickness of metal

1. Square foot
2. Cubic foot
3. Running foot
4. Square
5. Board foot
6. Surfaced lumber
7. Planer
8. Bill of materials
9. Rough stock
10. Gauge

2. Match the units of measure by which various materials are sold on the right to the correct materials.

______a. Lumber

______b. Steel

______c. Metal siding, roofing sheet iron, shingles

______d. Molding, some steel rods, chain cable

______e. Lathe, sometimes shingles when a square is broken

______f. Some steel products

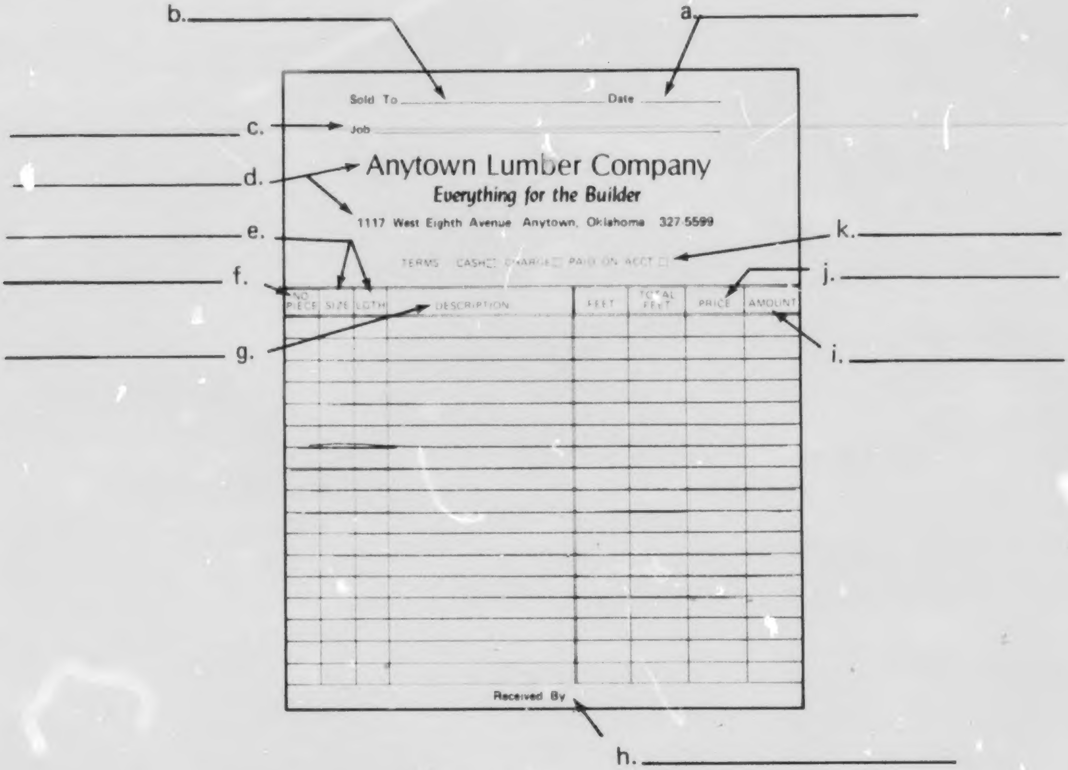
______g. Plywood, fiberboard, 4' X 8' sheets

1. Bundle
2. Weight
3. Board foot
4. Square
5. Running foot
6. Square foot
7. Sheet

3. Select from the lists below basic measurements in width and length by which most lumber is sold. Place an "X" in the correct blanks.

Width	Length
______a. 1/2 inch	______i. 6 feet
______b. 4 inches	______j. 4 feet
______c. 3/4 inch	______k. 2 feet
______d. 6 inches	______l. 8 feet
______e. 9 inches	______m. 14 feet
______f. 8 inches	______n. 12 feet
______g. 10 inches	______o. 16 feet
______h. 12 inches	______p. 18 feet

4. Identify the components of the bill of materials illustrated below.


b. ____
a. ____
c. ____
d. ____
e. ____
f. ____
g. ____
k. ____
j. ____
i. ____
h. ____

Sold To ____ Date ____
Job ____

Anytown Lumber Company
Everything for the Builder
1117 West Eighth Avenue Anytown, Oklahoma 327 5599

TERMS CASH☐ CHARGE☐ PAID ON ACCT ☐

NO. PIECE	SIZE	LGTH	DESCRIPTION	FEET	TOTAL FEET	PRICE	AMOUNT

Received By

5. Match symbols used in lumber selection on the right to the correct descriptions.

_____a. Surfaced on one side	1.	S4S
_____b. Surfaced on two sides	2.	S1E
_____c. Surfaced on one edge	3.	S1S
_____d. Surfaced on two edges	4.	S2E
_____e. Surfaced on all four sides	5.	S2S

6. Calculate board feet in the problems below.

a. 7 pieces 10" X 12" X 20'

b. 3 pieces 1" X 2" X 6'

7. Calculate the cost of materials in the following problems.

   a. Find the number of pounds of steel in a 10 ga sheet 48" X 96" if it weighs 5.625 pounds per square foot.

   b. What is the cost of 100 board feet of lumber if it costs $300 per thousand board feet?

8. Complete a bill of materials.

9. Determine cost of a project.

10. Estimate building materials.

    (NOTE: If activities eight, nine, and ten have not been accomplished prior to the test, ask the instructor when they should be completed.)

BILLS OF MATERIALS
UNIT II

ANSWERS TO TEST

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

5 a. Piece of lumber one inch thick, 12 inches long, and 12 inches wide

3 b. Foot length of a material regardless of thickness and width

1 c. Equal to a 12-inch by 12-inch surface regardless of thickness

4 d. Unit of measurement equal to 100 square feet of material

9 e. Lumber that has been sawed to dimension but not planed; usually thicker and wider

6 f. Lumber that has been surfaced by running through a planer

2 g. Measurement 12 inches long by 12 inches wide by 12 inches thick

8 h. Itemized list of the number and kind of pieces needed and the dimensions of each for the construction of a project

7 i. Machine that smoothes the surface of rough lumber

10 j. Unit of measure for thickness of metal

1. Square foot
2. Cubic foot
3. Running foot
4. Square
5. Board foot
6. Surfaced lumber
7. Planer
8. Bill of materials
9. Rough stock
10. Gauge

2. Match the units of measure by which various materials are sold on the right to the correct materials.

3 a. Lumber

2 b. Steel

4 c. Metal siding, roofing sheet iron, shingles

5 d. Molding, some steel rods, chain cable

1 e. Lathe, sometimes shingles when a square is broken

6 f. Some steel products

7 g. Plywood, fiberboard, 4' X 8' sheets

1. Bundle
2. Weight
3. Board foot
4. Square
5. Running foot
6. Square foot
7. Sheet

3. Select from the lists below basic measurements in width and length by which most lumber is sold. Place an "X" in the correct blanks.

Width

___ a. 1/2 inch

X b. 4 inches

___ c. 3/4 inch

X d. 6 inches

___ e. 9 inches

X f. 8 inches

X g. 10 inches

X h. 12 inches

Length

X i. 6 feet

___ j. 4 feet

___ k. 2 feet

X l. 8 feet

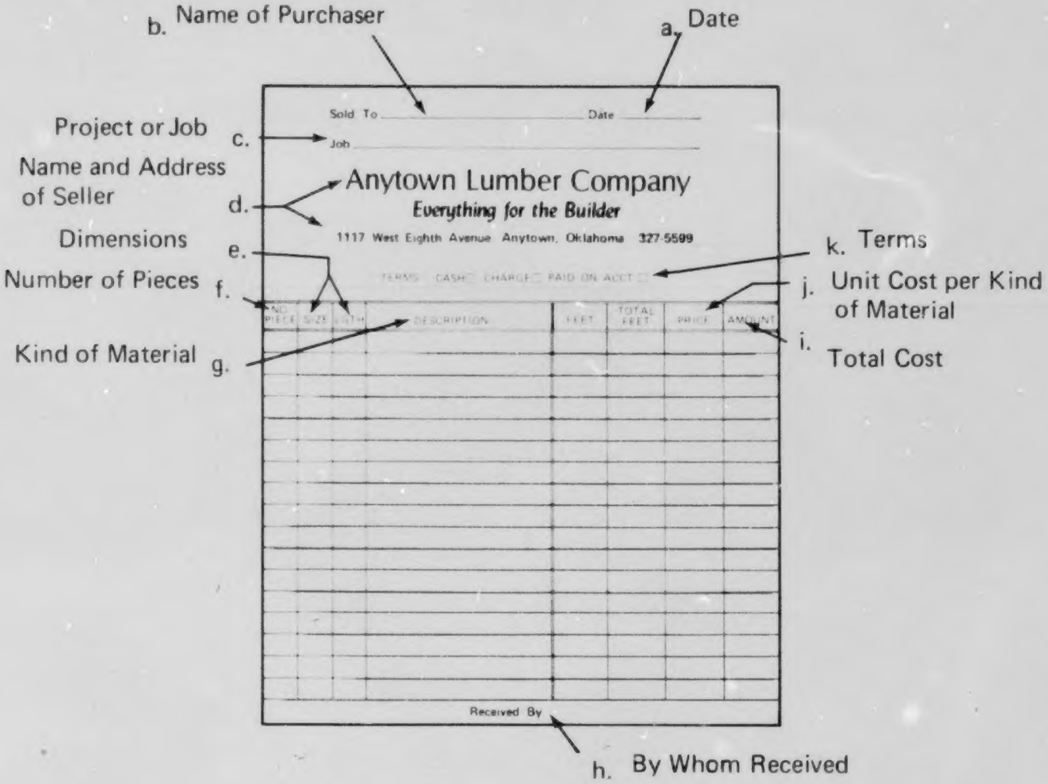
X m. 14 feet

X n. 12 feet

X o. 16 feet

___ p. 18 feet

4. Identify the components of the bill of materials illustrated below.



b. Name of Purchaser

a. Date

c. Project or Job

d. Name and Address of Seller

e. Dimensions

f. Number of Pieces

g. Kind of Material

h. By Whom Received

i. Total Cost

j. Unit Cost per Kind of Material

k. Terms

Sold To ______ Date ______

Job ______

Anytown Lumber Company

Everything for the Builder

1117 West Eighth Avenue Anytown, Oklahoma 327-5599

TERMS: CASH ☐ CHARGE ☐ PAID ON ACCT ☐

NO. PIECE	SIZE	LNTH	DESCRIPTION	FEET	TOTAL FEET	PRICE	AMOUNT

Received By

5. Match symbols used in lumber selection on the right to the correct descriptions.

3	a. Surfaced on one side	1.	S4S
5	b. Surfaced on two sides	2.	S1E
2	c. Surfaced on one edge	3.	S1S
4	d. Surfaced on two edges	4.	S2E
1	e. Surfaced on all four sides	5.	S2S

6. Calculate board feet in the problems below.

a. 7 pieces 10" X 12" X 20'

$$\frac{7 \times 10'' \times 12'' \times 20'}{12} = 1{,}400 \text{ board feet}$$

b. 3 pieces 1" X 2" X 6'

$$\frac{3 \times 1'' \times 2'' \times 6'}{12} = 3 \text{ board feet}$$

7. Calculate the cost of materials in the following problems.

   a. Find the number of pounds of steel in a 10 ga sheet 48" X 96" if it weighs 5.625 pounds per square foot.

      48" X 96" = 4' X 8' = 32 sq ft

      32 sq ft X 5.625 lb/sq ft = 180 lbs

   b. What is the cost of 100 board feet of lumber if it costs $300 per thousand board feet?

      $300/M = $.30/ft

      $.30 X 100 = $30.00

8. Complete a bill of materials.

9. Determine cost of a project.

10. Estimate building materials.

(NOTE: Activities eight, nine, and ten should be evaluated to the satisfaction of the instructor.)

FASTENERS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to define *fastener* and identify various types of fasteners. The student should be able to match the uses of various types of fasteners and select the most common sizes of nails. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define *fastener*.
2. Identify types of nails.
3. Match the types of nails to their uses.
4. Select from a list the most commonly used lengths of nails.
5. List types of coatings used on nails.
6. List materials used to manufacture nails.
7. Identify types of screw heads.
8. Identify common types of screws.
9. Match types of screws to their uses.
10. Select from a list items to specify when purchasing screws.
11. Identify types of bolts.
12. Match types of bolts to their uses.
13. Identify types of washers.
14. Identify types of nuts.
15. Identify types of hinges.
16. Match types of hinges to their uses.
17. Complete a chart on types of glue and their uses.
18. Identify types of rivet heads.
19. Name types of rivets.
20. List items to specify when purchasing rivets.

FASTENERS
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information sheet.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information sheet.

   F. Give test.

   (NOTE: Instructors may want to secure nail, screw, and bolt charts from the manufacturing companies for display in the shop.)

II. Unit references:

   A. Phipps, Lloyd J. *Mechanics in Agriculture.* Danville, Illinois: Interstate Printers and Publishers, Inc., 1967.

   B. Jones, Mack M. *Shopwork on the Farm.* New York: McGraw-Hill Book Co., 1954.

   C. *Hardware.* Indianapolis, Indiana: The National Retail Hardware Association, 1965.

   D. Feirer, John L. *Woodworking for Industry*. Peoria, Illinois: Charles A. Bennett Co., Inc., 1967.

   E. Feirer, John L. *General Metals.* Dallas, Texas: McGraw-Hill Book Company, 1959.

   F. Feirer, John L., and Lindbeck, John R. *Metalwork.* Peoria, Illinois: Charles A. Bennett Co., Inc., 1970.

   G. Groneman, Chris H., and Glazener, Everett R. *Technical Woodworking.* New York: McGraw-Hill Book Company, 1976.

FASTENERS
UNIT III

INFORMATION SHEET

I. Fastener--Any device, such as a nail, screw, rivet, or bolt, used to construct or give stability to an object

II. Types of nails (Transparency 1)

   A. Common

   B. Box

   C. Finishing

   D. Flooring

   E. Shingle

   F. Roofing

   G. Plaster board

   H. Hinge

   I. Duplex

   J. Wire staple

   K. Lead head

   L. Concrete

III. Types of nails and their uses

   A. Common--Used for nailing sheeting, shiplap, and fencing

   B. Box--Used for nailing siding

   C. Finishing--Used for interior finishing, for ceiling, and for cabinet work

   D. Flooring--Used in flooring work

   E. Shingle--Used in nailing shingles

   F. Roofing--Used in nailing rolled roofing and composition shingles

   G. Plaster board--Used in nailing plaster board

   H. Hinge--Used in fastening hinges

INFORMATION SHEET

I. Duplex--Used in form construction

J. Wire staple--Used in fence construction

K. Lead head--Used in nailing galvanized iron

(NOTE: Neoprene rings are more effective.)

L. Concrete--Used to fasten wood to concrete

IV. Lengths of nails

(NOTE: A small "d" is used to designate penny.)

Penny Size	Length in Inches For Common, Box, And Finish
2d	1
3d	1 1/4
4d	1 1/2
5d	1 3/4
* 6d	2
7d	2 1/4
* 8d	2 1/2
9d	2 3/4
10d	3
12d	3 1/4
*16d	3 1/2
*20d	4
30d	4 1/2
40d	5
50d	5 1/2
60d	6

* Sizes most commonly used

V. Coatings for nails

A. Cement

B. Galvanized

C. Cadmium plated

D. Glue

VI. Materials used to manufacture nails

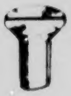
A. Steel

B. Aluminum

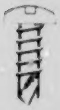
INFORMATION SHEET

VII. Types of screw heads

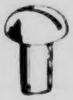
A. Flat head



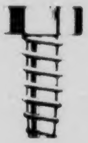
B. Pan head



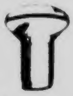
C. Round head



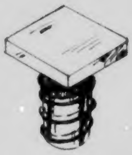
D. Hex head



E. Oval head



F. Square head



(NOTE: Other screw heads are for special purposes.)

VIII. Common types of screws (Transparency 2)

A. Lag

B. Flat head

C. Oval head

D. Round head

E. Phillips

IX. Types of screws and their uses

A. Lag--Used in fastening wood to brick or concrete

B. Flat head--Used for strength in wood work (usually countersunk)

C. Oval head--Used in cabinet work and for attaching hinges

D. Round head--Used for flush mounting wood

E. Phillips--Usually used in auto industry

X. Specifications required when purchasing screws

A. Length

B. Size

INFORMATION SHEET

- C. Quantity
- D. Type of head
- E. Finish
- F. Use

XI. Types of bolts (Transparency 3)

- A. Machine
- B. Carriage
- C. Stove
  - 1. Round head
  - 2. Flat head
- D. Plow
- E. Toggle
- F. Expansion

(NOTE: The following are special made bolts designed for specific purposes.)

- 1. U-bolt
- 2. Eye bolt
- 3. Hook bolt
- 4. Turnbuckle

XII. Types of bolts and their uses

- A. Machine-Used in assembling machinery
- B. Carriage-Used in fastening wood and other soft materials
- C. Round head stove-Used in sheet metal work; general purpose bolt
- D. Flat head stove-Used in sheet metal work; general purpose bolt; is countersunk
- E. Plow-Used for fastening tillage implements
- F. Toggle-Used in fastening objects to hollow walls
- G. Expansion-Used in fastening material to concrete walls or floors

INFORMATION SHEET

XIII. Types of washers (Transparency 4)

- A. Plain (flat)
- B. Lock
    1. Common
    2. External
    3. Internal
    4. Internal-External
    5. Countersunk

XIV. Types of nuts (Transparency 5)

- A. Square
- B. Hexagon
- C. Acorn or cap
- D. Jam or lock
- E. Castle
- F. Wing
- G. Self-locking

XV. Types of hinges (Transparency 6)

- A. Strap
- B. T
- C. Butt
- D. Screw hook and strap
- E. Cabinet
- F. Hasp

XVI. Types of hinges and their uses

- A. Strap--Used in heavy construction
- B. T--Used when butt end is fastened into a studding
- C. Butt--Used in cabinet work

INFORMATION SHEET

D. Screw hook and strap Used in hinging gates

E Cabinet Used in cabinet work

F. Hasp Used in fastening doors, provides a place for a lock

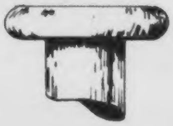
XVII. Types of glue and their uses

Adhesive	ⓧ Best product for this use X Acceptable for this use Properties	Wood to wood and plywood	Wood veneering	Plastic laminates to wood	Wood boats and marine uses	Wood for outdoor use	Metal to wood	China repair	Patch seal solder	Metal to metal	Paper to paper or cloth*	Leather to leather or wood	Rubber to wood or metal	Cloth to cloth or wood
Aliphatic resin	Liquid, ready-to-use aliphatic resin. Tacky, highest strength. Good heat resistance. Durable. Tough bond.	ⓧ	X	X							X	X		X
White glue	Liquid ready-to-use polyvinyl acetate resin. Sets fast (20-30 min clamp). Dries clear.	X	X	X							ⓧ	X		ⓧ
Liquid hide glue	Liquid, ready-to-use brown animal glue. Reliable. Clamping time 40-50 min.	X	X	ⓧ							X	ⓧ		X
Contact cement	Liquid, ready-to-use neoprene-based adhesive. No clamping needed. Water resistant.		ⓧ	X						X		X	ⓧ	X
Plastic resin	Powdered, urea based. Mixes easily with water. Good water resistance. Requires 6-8 hours clamping.	X	X	X		X								
Waterproof	Two-part resorcinol resin adhesive. Fully waterproof. Requires overnight clamping.	X	X	X	ⓧ	ⓧ								
Casein	Powdered glue. Mix with water. Water resistant.	X	X	X										
Epoxy cement	Two part: resin and hardener. Bonds almost anything. Requires 8-10 hours setting time.						ⓧ	X	X	ⓧ				
Household cement	Liquid: clear and fast drying (5-15 min). Vinyl base. Water resistant.							ⓧ			X			X
Liquid solder	Liquid-requires no heat or mixing. Water resistant.								ⓧ					

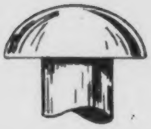
INFORMATION SHEET

XVIII. Types of rivet heads

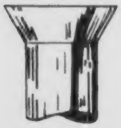
A. Flat



B. Round



C. Countersunk



XIX. Types of rivets

A. Solid

B. Hollow

C. Explosive

D. Two-part (male and female)

E. Blind or pop

(NOTE: Rivets are made of several kinds of materials: aluminum, copper, brass, mild steel or black iron, and magnesium. They also come in various sizes and lengths.)

XX. Items to specify when purchasing rivets

A. Kind of metal

B. Kind of head

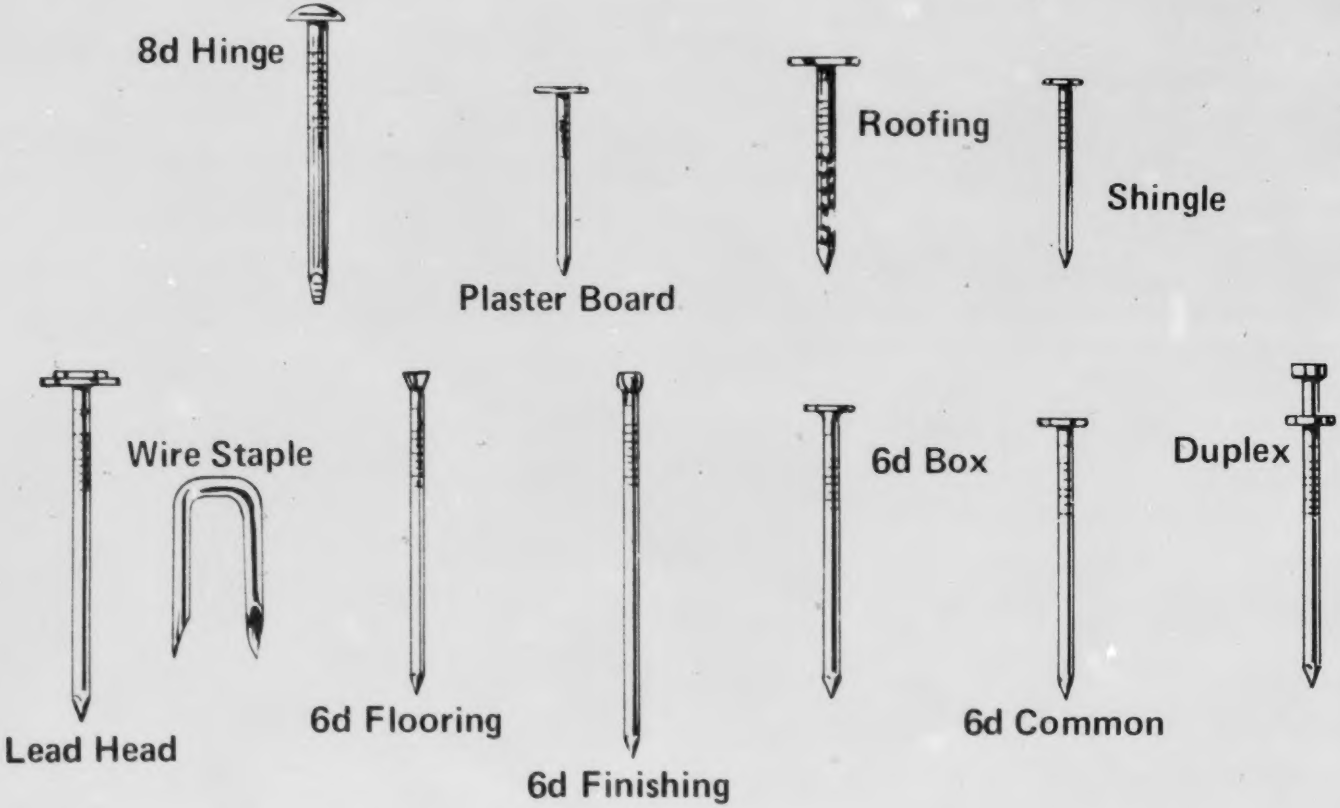
C. Diameter

D. Length

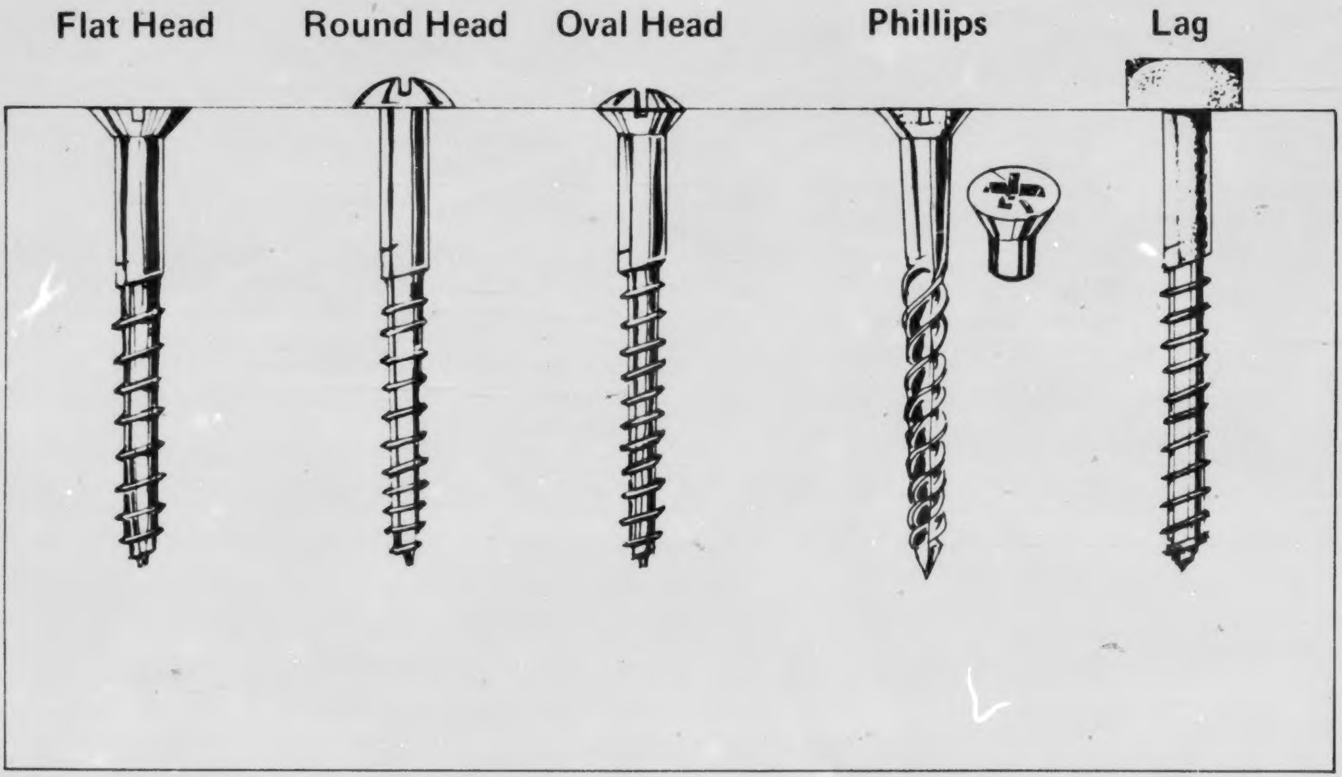
E. Type

F. Use

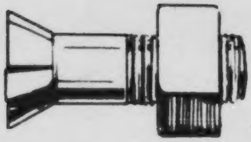
Types of Nails

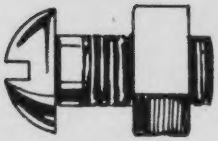

8d Hinge
Plaster Board
Roofing
Shingle
Wire Staple
Lead Head
6d Flooring
6d Finishing
6d Box
6d Common
Duplex

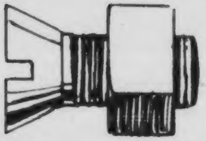
Types of Screws

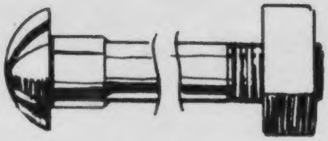

Flat Head
Round Head
Oval Head
Phillips
Lag

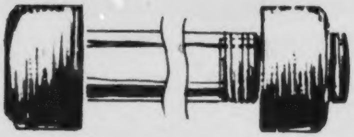
Types of Bolts

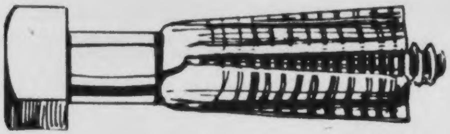

Plow

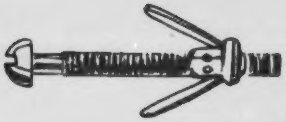

Round Head Stove

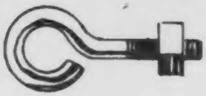

Flat Head Stove

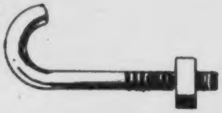

Carriage

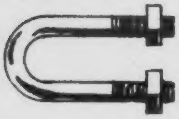

Machine

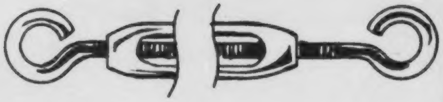

Expansion


Toggle

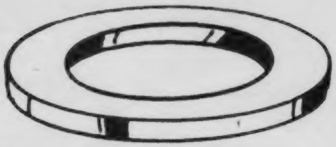

Eye Bolt


Hook Bolt

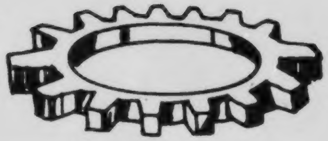

U Bolt


Turnbuckle

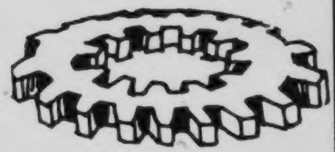
Types of Washers



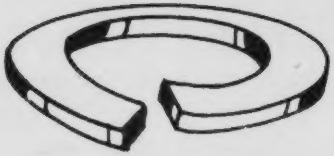
Plain Flat Washer



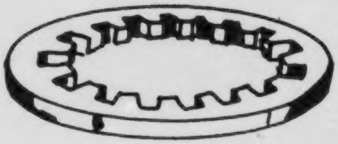
Lock Washer
External



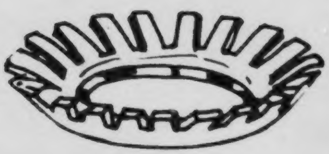
Lock Washer
Internal-External



Common
Lock Washer

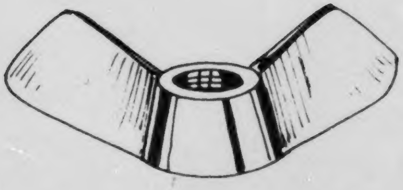


Lock Washer
Internal

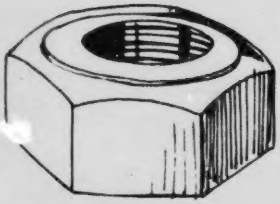


Lock Washer
Countersunk

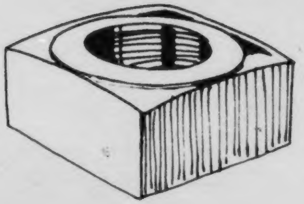
Types of Nuts



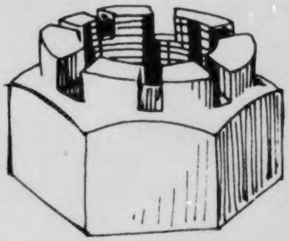
Wing Nut



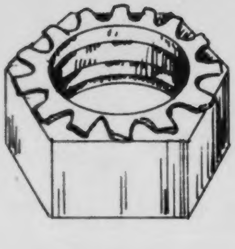
Hexagon



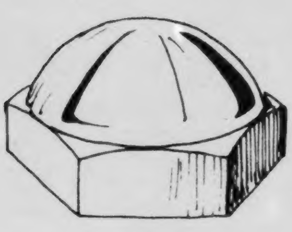
Square



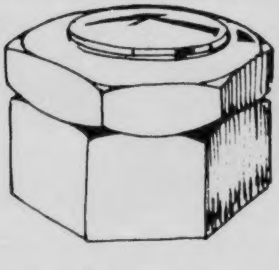
Castle



Self-Locking

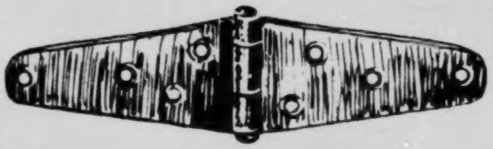


Acorn or Cap

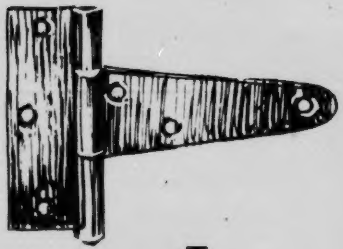


Jam or Lock

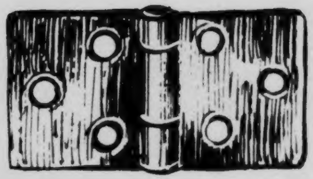
Types of Hinges



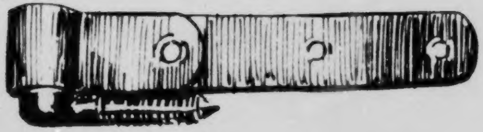
Strap



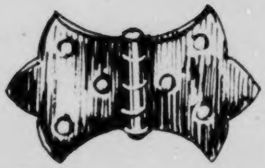
T



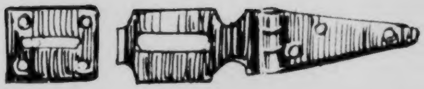
Butt



Screw Hook and Strap



Cabinet



Hasp

FASTENERS
UNIT III

TEST

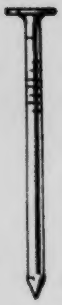
NAME ______________________________ SCORE ________________

1. Define *fastener*.

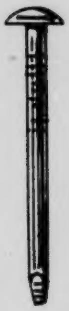
____

____

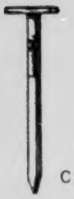
2. Identify the following types of nails.



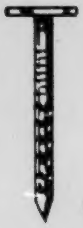
a. ____________________



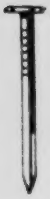
b. ____________________



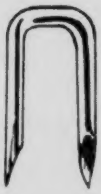
c. ____________________



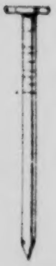
d. ____________________



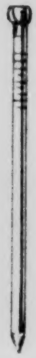
e. ____________________



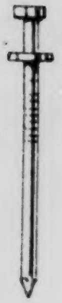
f. ____________________



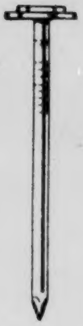
g. ____________________



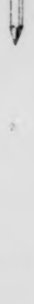
h. ____________________



i. ____________________



j. ____________________



k. ____________________

3. Match the types of nails on the right to the correct uses on the left by placing the appropriate numbers in the blanks provided.

______a. Used for interior finishing, for ceiling, and for cabinet work

______b. Used in nailing shingles

______c. Used in nailing plaster board

______d. Used in form construction

______e. Used in nailing galvanized iron

______f. Used for nailing sheeting, shiplap, and fencing

______g. Used for nailing siding

______h. Used in flooring work

______i. Used in nailing rolled roofing and composition shingles

______j. Used in fastening hinges

______k. Used in fence construction

______l. Used to fasten wood to concrete

1. Common
2. Box
3. Shingle
4. Roofing
5. Wire staple
6. Flooring
7. Plaster board
8. Hinge
9. Duplex
10. Lead head
11. Finishing
12. Concrete

4. Select from the following list the most commonly used lengths of nails. Place an "X" in the appropriate blanks.

______a. 2d

______b. 3d

______c. 4d

______d. 5d

______e. 6d

______f. 7d

______g. 8d

______h. 10d

______i. 12d

______j. 16d

______k. 20d

______l. 30d

______m. 40d

______n. 60d

5. List the types of coatings used on nails.

a. ____

b. ____

c. ____

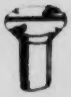
d. ____

6. List materials used to manufacture nails.

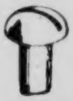
   a. ____________________

   b. ____________________

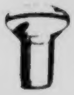
7. Identify the following types of screw heads.



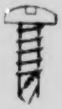
a. ____________________



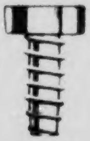
b. ____________________



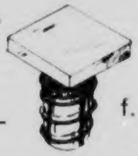
c. ____________________



d. ____________________

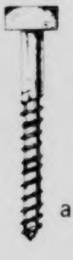


e. ____________________

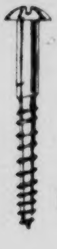


f. ____________________

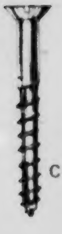
8. Identify the following common types of screws.



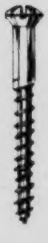
a. ____________________



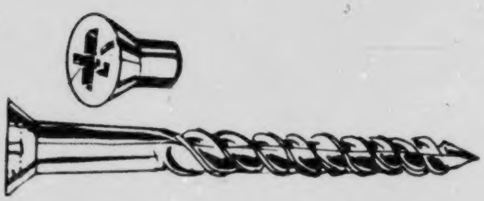
b. ____________________



c. ____________________



d. ____________________



e. ____________________

9. Match the types of screws on the right to the correct uses on the left. Place the appropriate numbers in the blanks provided.

_____a. Used for strength in wood work (usually countersunk)

_____b. Usually used in auto industry

_____c. Used in fastening wood to brick or concrete

_____d. Used for flush mounting wood

_____e. Used in cabinet work and for attaching hinges

1. Lag
2. Flat head
3. Oval head
4. Round head
5. Phillips

10. Select from the list below items to specify when purchasing screws. Place an "X" in the blanks.

_____a. Length

_____b. Color

_____c. Size

_____d. Quantity

_____e. Quality

_____f. Type of head

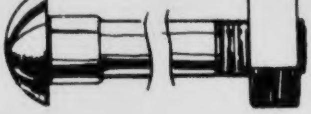
_____g. Waterproof

_____h. Finish

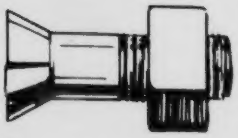
_____i. Type of thread

_____j. Penny weight

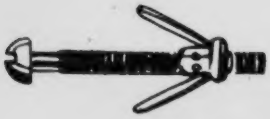
11. Identify the following types of bolts.



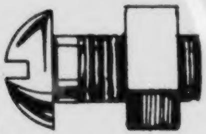
a. ____________________



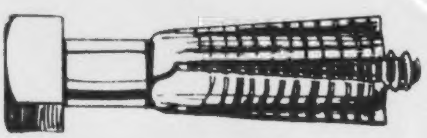
b. ____________________



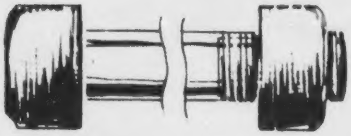
c. ____________________



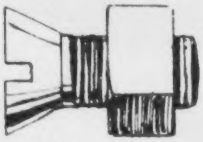
d. ____________________



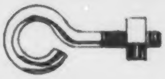
e. ______________________



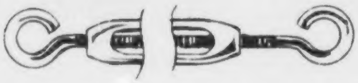
f. ______________________



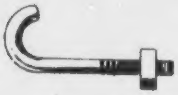
g. ______________________



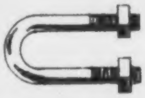
h. ______________________



i. ______________________



j. ______________________



k. ______________________

12. Match the types of bolts on the right to the correct uses on the left. Place the appropriate numbers in the blanks provided.

______a. Used in assembling machinery

______b. Used in fastening wood and other soft materials

______c. Used in sheet metal work; general purpose bolt

______d. Used in fastening objects to hollow walls

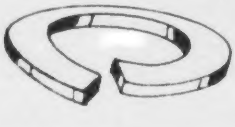
______e. Used in fastening material to concrete walls or floors

______f. Used for fastening tillage implements

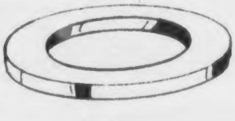
______g. Used in sheet metal work; general purpose bolt; is countersunk

1. Machine
2. Carriage
3. Round head stove
4. Flat head stove
5. Plow
6. Toggle
7. Expansion

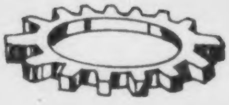
13. Identify the following types of washers.



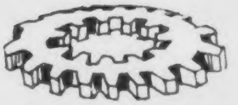
a. ______________________



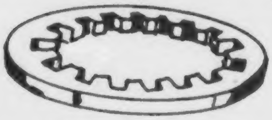
b. ______________________



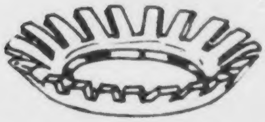
c. ________________



d. ________________

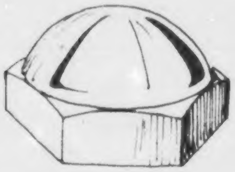


e. ________________

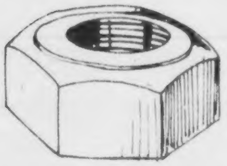


f. ________________

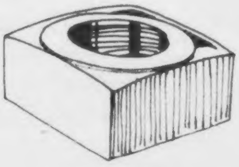
14. Identify the following types of nuts.



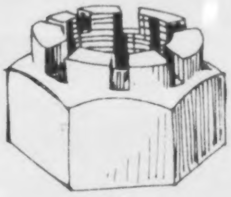
a. ________________



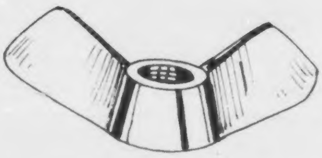
b. ________________



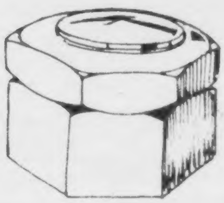
c. ________________



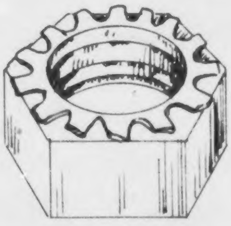
d. ________________



e. ________________

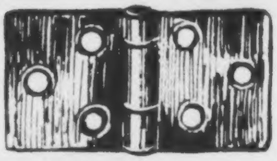


f. ________________

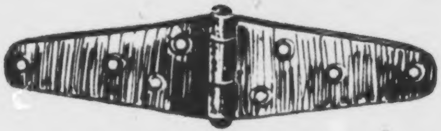


g. ________________

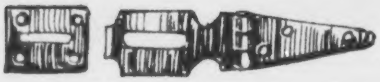
15. Identify the following types of hinges.



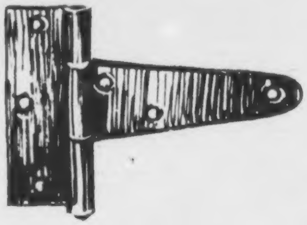
a. ______________________



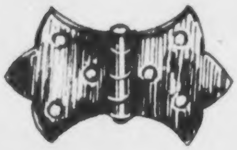
b. ______________________



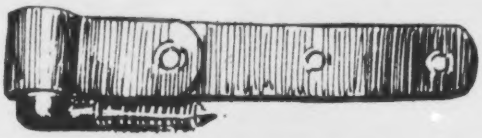
c. ______________________



d. ______________________



e. ______________________



f. ______________________

16. Match the types of hinges on the right to the uses on the left. A blank may have more than one correct answer.

_____a. Used when butt end is fastened into a studding

_____b. Used in hinging gates

_____c. Used in fastening doors; provides a place for a lock

_____d. Used in heavy construction

_____e. Used in cabinet work

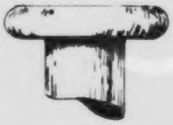
1. Strap
2. T
3. Butt
4. Screw hook and strap
5. Cabinet
6. Hasp

17. Complete the following chart on types of glue by placing an "X" under the material for which the glue is used.

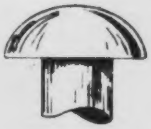
Ⓧ-Best product for this use
X-Acceptable for this use

Adhesive	Properties	Wood to wood and plywood	Wood veneering	Plastic laminates to wood	Wood boats and marine uses	Wood for outdoor use	Metal to wood	China repair	Patch seal solder	Metal to metal	Paper to paper or cloth	Leather to leather or wood	Rubber to wood or metal	Cloth to cloth or wood
Aliphatic resin	Liquid, ready-to-use aliphatic resin. Tacky, highest strength. Good heat resistance. Durable. Tough bond.													
White glue	Liquid ready-to-use polyvinyl acetate resin. Sets fast (20-30 min clamp). Dries clear.													
Liquid hide glue	Liquid, ready-to-use brown animal glue. Reliable. Clamping time 40-50 min.													
Contact cement	Liquid, ready-to-use neoprenebased adhesive. No clamping needed. Water resistant.													
Plastic resin	Powdered, urea based. Mixes easily with water. Good water resistance. Requires 6-8 hours clamping.													
Waterproof	Two-part resorcinol resin adhesive. Fully waterproof. Requires overnight clamping.													
Casein	Powdered glue. Mix with water. Water resistant.													
Epoxy cement	Two part: resin and hardener. Bonds almost anything. Requires 8-10 hours setting time.													
Household cement	Liquid: clear and fast drying (5-15 min). Vinyl base. Water resistant.													
Liquid solder	Liquid--requires no heat or mixing. Water resistant.													

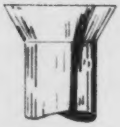
18. Identify the types of rivet heads below by writing the correct names in the blanks provided.



a.



b.



c.

19. Name four types of rivets.

a.

b.

c.

d.

20. List the items to specify when purchasing rivets.

a.

b.

c.

d.

e.

f.

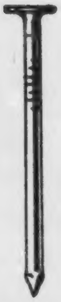
FASTENERS
UNIT III

ANSWERS TO TEST

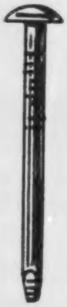
1. Define *fastener*.

   Any device, such as a nail, screw, rivet, or bolt, used to construct or give stability to an object

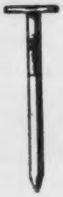
2. Identify the following types of nails.



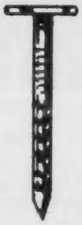
a. Box



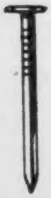
b. Hinge



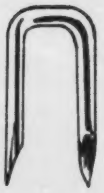
c. Plaster board



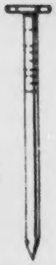
d. Roofing



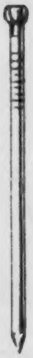
e. Shingle



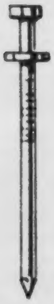
f. Wire staple



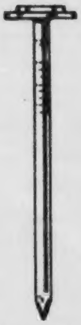
g. Common



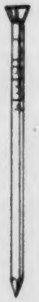
h. Finishing



i. Duplex



j. Lead head



k. Flooring

3. Match the types of nails on the right to the correct uses on the left by placing the appropriate numbers in the blanks provided.

11 a. Used for interior finishing, for ceiling, and for cabinet work

3 b. Used in nailing shingles

7 c. Used in nailing plaster board

9 d. Used in form construction

10 e. Used in nailing galvanized iron

1 f. Used for nailing sheeting, shiplap, and fencing

2 g. Used for nailing siding

6 h. Used in flooring work

4 i. Used in nailing rolled roofing and composition shingles

8 j. Used in fastening hinges

5 k. Used in fence construction

12 l. Used to fasten wood to concrete

1. Common
2. Box
3. Shingle
4. Roofing
5. Wire staple
6. Flooring
7. Plaster board
8. Hinge
9. Duplex
10. Lead head
11. Finishing
12. Concrete

4. Select from the following list the most commonly used lengths of nails. Place an "X" in the appropriate blanks.

______ a. 2d

______ b. 3d

______ c. 4d

______ d. 5d

X e. 6d

______ f. 7d

X g. 8d

______ h. 10d

______ i. 12d

X j. 16d

X k. 20d

______ l. 30d

______ m. 40d

______ n. 60d

5. List the types of coatings used on nails.

a. Cement

b. Galvanized

c. Cadmium plated

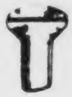
d. Glue

6. List materials used to manufacture nails.

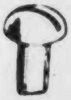
   a. Steel

   b. Aluminum

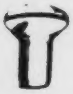
7. Identify the following types of screw heads.



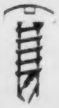
a. Flat



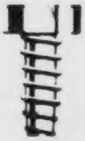
b. Round



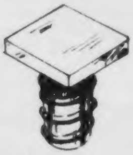
c. Oval



d. Pan

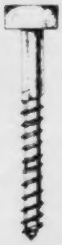


e. Hex

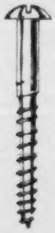


f. Square

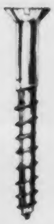
8. Identify the following common types of screws.



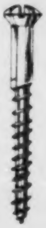
a. Lag



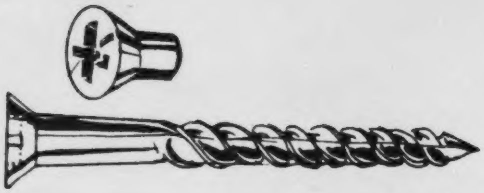
b. Round head



c. Flat head



d. Oval head



e. Phillips

9. Match the types of screws on the right to the correct uses on the left. Place the appropriate numbers in the blanks provided.

____2____ a. Used for strength in wood work (usually countersunk)

____5____ b. Usually used in auto industry

____1____ c. Used in fastening wood to brick or concrete

____4____ d. Used for flush mounting wood

____3____ e. Used in cabinet work and for attaching hinges

1. Lag
2. Flat head
3. Oval head
4. Round head
5. Phillips

10. Select from the list below items to specify when purchasing screws. Place an "X" in the correct blanks.

____X____ a. Length

________ b. Color

____X____ c. Size

____X____ d. Quantity

________ e. Quality

____X____ f. Type of head

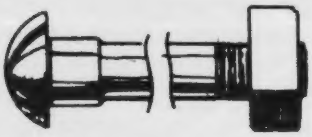
________ g. Waterproof

____X____ h. Finish

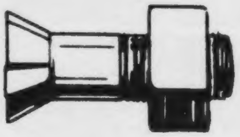
________ i. Type of thread

________ j. Penny weight

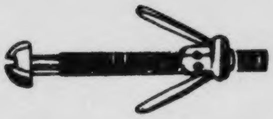
11. Identify the following types of bolts.



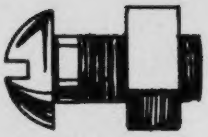
a. Carriage



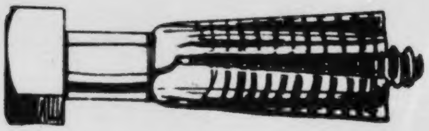
b. Plow



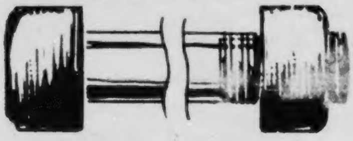
c. Toggle



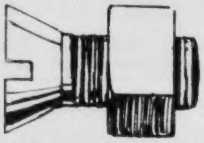
d. Round head stove



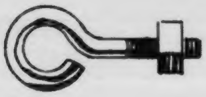
e. Expansion



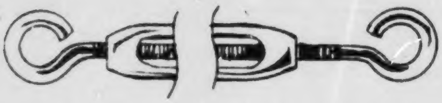
f. Machine



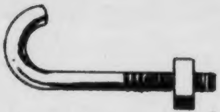
g. Flat head stove



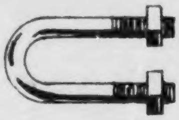
h. Eye bolt



i. Turnbuckle



j. Hook bolt



k. U-bolt

12. Match the types of bolts on the right to the correct uses on the left. Place the appropriate numbers in the blanks provided.

1 a. Used in assembling machinery

2 b. Used in fastening wood and other soft materials

3 c. Used in sheet metal work; general purpose bolt

6 d. Used in fastening objects to hollow walls

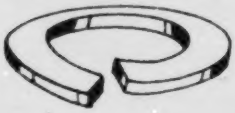
7 e. Used in fastening material to concrete walls or floors

5 f. Used for fastening tillage implements

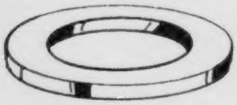
4 g. Used in sheet metal work; general purpose bolt; is countersunk

1. Machine
2. Carriage
3. Round head stove
4. Flat head stove
5. Plow
6. Toggle
7. Expansion

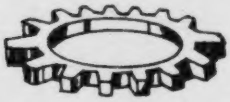
13. Identify the following types of washers.



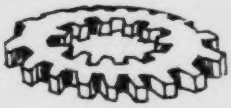
a. Common lock



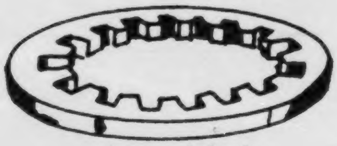
b. Plain (flat)



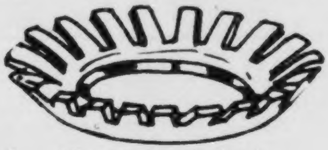
c. External lock



d. Internal-External lock

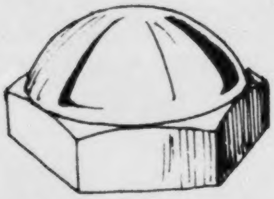


e. Internal lock

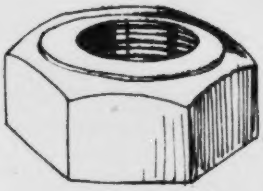


f. Countersunk lock

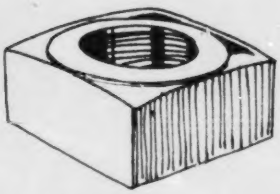
14. Identify the following types of nuts.



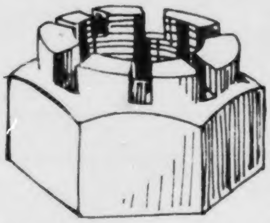
a. Acorn or cap



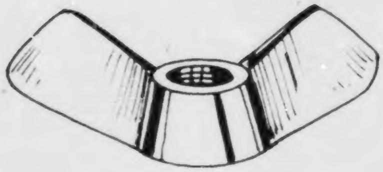
b. Hexagon



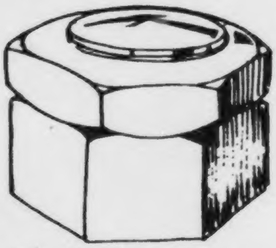
c. Square



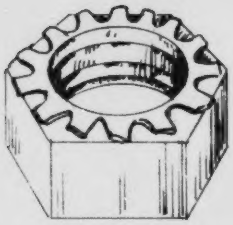
d. Castle



e. Wing

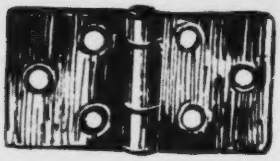


f. Jam or lock

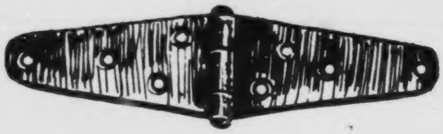


g. Self-locking

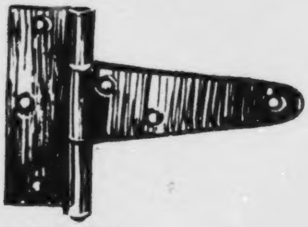
15. Identify the following types of hinges.



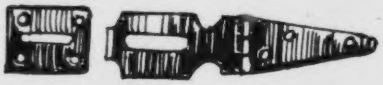
a. Butt



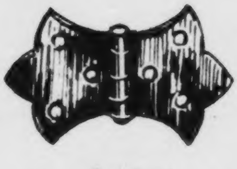
b. Strap



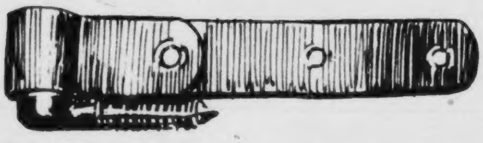
d. T



c. Hasp



e. Cabinet



f. Screw hook and strap

16. Match the types of hinges on the right to the uses on the left. A blank may have more than one correct answer.

2 a. Used when butt end is fastened into a studding

4 b. Used in hinging gates

6 c. Used in fastening doors; provides a place for a lock

1 d. Used in heavy construction

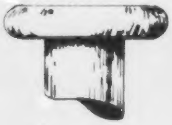
3,5 e. Used in cabinet work

1. Strap
2. T
3. Butt
4. Screw hook and strap
5. Cabinet
6. Hasp

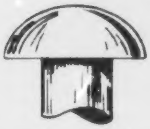
17. Complete the following chart on types of glue by placing an "X" under the material for which the glue is used.

Ⓧ-Best product for this use X-Acceptable for this use Adhesive	Properties	Wood to wood and plywood	Wood veneering	Plastic laminates to wood	Wood boats and marine uses	Wood for outdoor use	Metal to wood	China repair	Patch seal solder	Metal to metal	Paper to paper or cloth	Leather to leather or wood	Rubber to wood or metal	Cloth to cloth or wood
Aliphatic resin	Liquid, ready-to-use aliphatic resin. Tacky, highest strength. Good heat resistance. Durable. Tough bond.	Ⓧ	X	X							X	X		X
White glue	Liquid ready-to-use polyvinyl acetate resin. Sets fast (20-30 min clamp). Dries clear.	X	X	X							Ⓧ	X		Ⓧ
Liquid hide glue	Liquid, ready-to-use brown animal glue. Reliable. Clamping time 40-50 min.	X	X	Ⓧ							X	Ⓧ		X
Contact cement	Liquid, ready-to-use neoprenebased adhesive. No clamping needed. Water resistant.		Ⓧ	X						X		X	Ⓧ	X
Plastic resin	Powdered, urea based. Mixes easily with water. Good water resistance. Requires 6-8 hours clamping.	X	X	X		X								
Waterproof	Two-part resorcinol resin adhesive. Fully waterproof. Reouires overnight clamping.	X	X	X	Ⓧ	Ⓧ								
Casein	Powdered glue. Mix with water. Water resistant.	X	X	X										
Epoxy cement	Two part: resin and hardener. Bonds almost anything. Requires 8-10 hours setting time.						Ⓧ	X	X	Ⓧ				
Household cement	Liquid: clear and fast drying (5-15 min). Vinyl base. Water resistant.							Ⓧ			X			X
Liquid solder	Liquid-requires no heat or mixing. Water resistant.								Ⓧ					

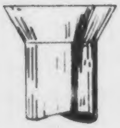
18. Identify the types of rivet heads below by writing the correct names in the blanks provided.



a. Flat



b. Round



c. Countersunk

19. Name four types of rivets.

(NOTE: Any four of the following are acceptable.)

a. Solid

b. Hollow

c. Explosive

d. Two-part (male and female)

e. Blind or pop

20. List the items to specify when purchasing rivets.

a. Kind of metal

b. Kind of head

c. Diameter

d. Length

e. Type

f. Use

CONCRETE
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to list the ingredients of concrete and factors that determine maximum size of aggregate used in concrete. The student should be able to select proper mixes of concrete for specific jobs. The student should be able to identify tools used in concrete work and calculate amounts of concrete needed for a specific job. This knowledge will be evidenced through demonstration and by scoring 85 percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with concrete to the correct definitions.
2. Select from a list reasons why concrete is widely used in agriculture.
3. List the ingredients of concrete.
4. Match types of portland cement to correct descriptions.
5. Identify the meaning of numbers in concrete mixes.
6. Select from a list factors that determine quality, durability, and strength of concrete.
7. List factors that determine maximum size of aggregate used in concrete.
8. Identify tools used in concrete work.
9. State the effects of proper curing on the quality of finished concrete.
10. Arrange in order the procedure for curing concrete.
11. List kinds of reinforcement used in concrete.
12. Match sizes of reinforcing bars to bar numbers.
13. List characteristics of a good form.
14. Select from a list types of finishes for concrete floors.
15. Calculate problems in estimating materials for concrete construction.

CONCRETE
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Provide student with practice in mixing various mixes of concrete.

   (NOTE: Instructors can use a lime mortar mix for laboratory experience. It can be reused by adding water and remixing.)

   G. Give test.

II. Unit references:

   A. Ahrens, Donald L. *Concrete and Concrete Masonry*. St. Paul, Minn.: Harbor Publications, 1976.

   B. *Concrete Technology*. Albany, N.Y.: Delmar Publishers, Inc., 1965.

   C. Phipps, Lloyd J. *Mechanics in Agriculture,* Danville, Ill.: The Interstate Printers and Publishers, Inc., 1967.

CONCRETE
UNIT IV

INFORMATION SHEET

I. Terms and definitions

  A. Cement--Finely-ground manufactured product mixed with water to form the paste to make concrete; active ingredient of concrete

  B. Concrete--Artificial stone; composed of a mixture of portland cement, sand, aggregate, and water

  C. Aggregate--Hard, rock-like mass of sand, gravel, or crushed rock; one of the principle ingredients of concrete

  D. Hydration--Chemical process that takes place between cement and water

  E. Reinforcing--Material added to concrete to increase tensile strength

  F. Footing--Base upon which a foundation of a building is set

  G. Ready-mix concrete--Concrete ingredients are proportioned at central location and blended on way to job; provides concrete that is ready to use when it arrives at the job site

  H. Screed--Straightedge used to level concrete after being placed in form

  I. Cubic yard--Volume formed by a cube having a dimension of three feet on each side

  J. Curing--Process of preventing the evaporation of moisture from concrete

  K. Form--Enclosure made of either wood or metal for holding fresh concrete to the desired shape until it has set and thoroughly dried

  L. Ready-to-use concrete mix--Concrete mix purchased in small amounts (cubic foot bag) with ingredients already mixed in proper proportions

II. Reasons why concrete is widely used in agriculture

  A. Adaptable and serviceable in a variety of situations

  B. Permanent when properly made

  C. Sanitary and easily cleaned

  D. Fireproof

INFORMATION SHEET

E. Rat, insect, and rodent proof

F. Used for almost any purpose when properly reinforced

G. May be made attractive and decorative

H. Economical in installation and maintenance

I. Waterproof when properly cured

III. Ingredients of concrete

A. Portland cement

B. Sand

C. Aggregate

D. Water

IV. Types of portland cement

(NOTE: Do not use masonry cement for portland cement.)

A. Type I--General purpose cement; called normal portland cement

B. Type II--Modified portland cement; used where there may be a moderate sulfate attack or concern of heat build-up

C. Type III--High-early-strength portland cement; used to obtain strength in one to three days after casting

D. Type IV--Low heat portland cement; designed to reduce the amount and rate of heat generated in curing large masses of concrete, such as large dams

E. Type V--Sulfate resistant portland cement; used where concrete will be exposed to water or soil having a high alkali content

(NOTE: Air-entrained portland cement is designated by Types IA, IIA, and IIIA. They contain small quantities of air-entraining agents which make pores in finished concrete to make it resistant to severe frost.)

V. Meaning of numbers in concrete mixes (Transparency 1)

(NOTE: The numbers are expressed in a ratio.)

A. First number--Parts (cu ft) of cement

B. Second number--Parts (cu ft) of sand

INFORMATION SHEET

C. Third number--Parts (cu ft) of aggregate

D. Fourth number--Gallons of water

Example: 1:2:3-6 means 1 cubic foot of cement: 2 cubic feet of sand: 3 cubic feet of aggregate - 6 gallons of water

VI. Factors that determine quality, durability, and strength of concrete

(NOTE: Strength is determined by the amount of water. The drier the mix, the stronger the concrete.)

A. Quality and amount of cement used

B. Kind, size, and amount of aggregate used

C. Amount of clean water used

D. Way ingredients are mixed and placed

E. Proper curing of mixture after it is placed

F. Amount and kind of reinforcement

VII. Maximum size of aggregate used in concrete

A. Should be determined by size and shape of concrete member

B. Should not exceed one-fifth the dimension of nonreinforced slabs on grade

C. Should not exceed three-fourths the clear spacing between reinforcing bars or between reinforcing bar and form

D. Should not exceed one-third the depth of nonreinforced slabs on grade

VIII. Tools used in concrete work (Transparencies 2 and 3)

A. Bullfloat

B. Edger

C. Jointer or groover

D. Wood float

E. Magnesium float

F. Finishing trowel

G. Power trowel

INFORMATION SHEET

H. Pointing trowel

I. Brick trowel

J. Jointing tool

K. Concrete mixer

L. Jitterbug

IX. Effects of proper curing on the quality of finished concrete

A. Strength is increased very rapidly

B. Quality is improved

C. Concrete cured in moist air for two days is 50% stronger than concrete exposed to dry air

X. Procedure for curing concrete

(NOTE: Experience is the only true measure for determining methods and procedures for curing.)

A. Rod concrete to level (using straightedge) as soon as possible after placing or pouring

B. Protect concrete so water will not evaporate too quickly

(NOTE: Concrete curing is dependent on water for the chemical process of hardening to take place.)

C. Use jitterbug to compact placed or poured concrete

D. Float the slab with a hand float or bullfloat, depending on size of area

E. Use proper equipment to give desired finish

Example: Trowel for smooth finish; broom for rough, coarse finish

F. Cover to protect from weather

(NOTE: Fresh concrete needs protection below 40°F and above 90°F.)

G. Cure for a minimum of three days

(NOTE: Methods of curing include covering with water, use of water-retaining agents, use of mechanical barriers, and use of chemical membrane. DO NOT let concrete freeze or dry too quickly.)

INFORMATION SHEET

XI. Kinds of reinforcement used in concrete

A. Bar

(NOTE: There will be several variations of the bar used for reinforcement in concrete.)

B. Welded wire fabric

XII. Size and number of reinforcing bars

Number	Size in Diameter
#2	1/4"
#3	3/8"
#4	1/2"
#5	5/8"
#6	3/4"
#7	7/8"
#8	1"

(NOTE: To determine size of bars, divide the bar number by eight. For example, #6 ÷ 8 = 3/4".)

XIII. Characteristics of a good form

(NOTE: Coat wood forms with a light oil to aid in removal.)

A. Strong and rigid

B. Smooth finish

C. Easily removed

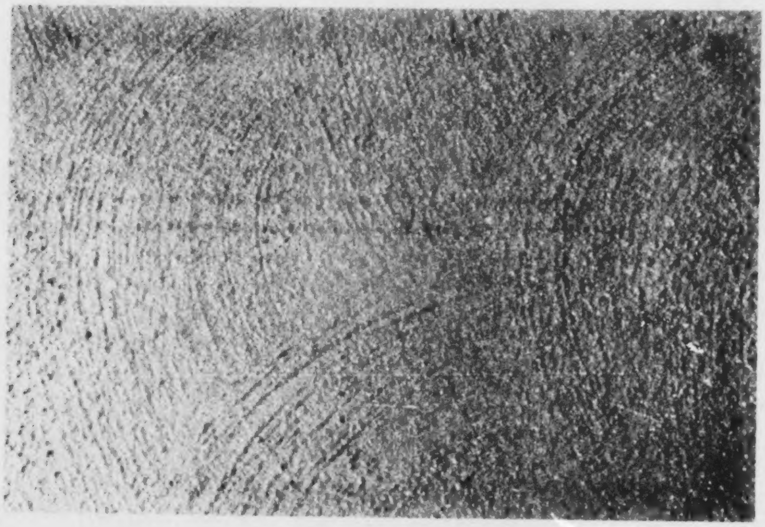
D. Reuseable

INFORMATION SHEET

XIV. Types of finishes for concrete floors

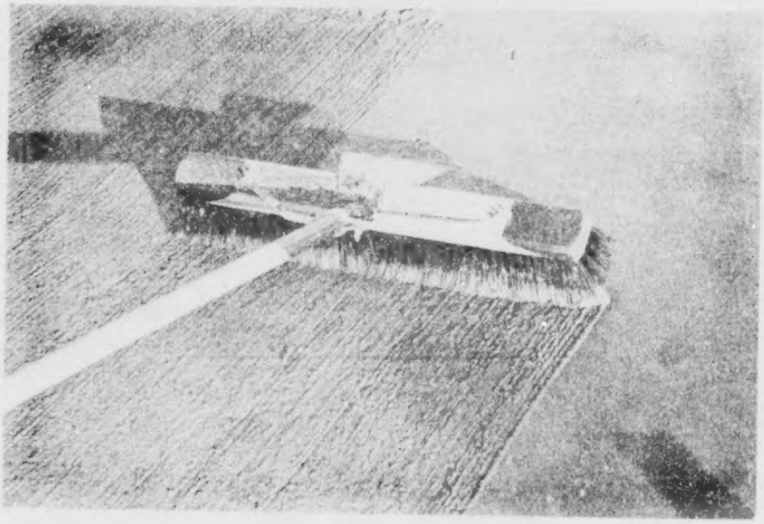
A. Float

(NOTE: This is used where a smooth finish is not needed.)



B. Rough broom

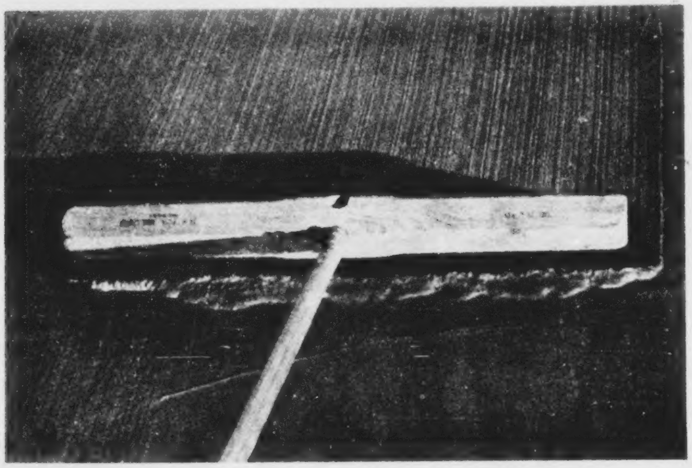
(NOTE: This is used for livestock areas where good footing is necessary.)



INFORMATION SHEET

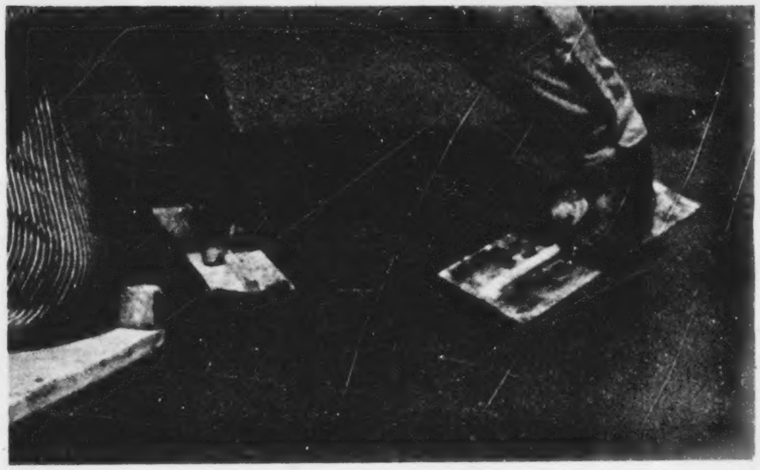
C. Fine broom

(NOTE: This is used for hog confinement areas. Good footing is necessary but the surface must be smooth enough to clean.)



D. Hand trowel

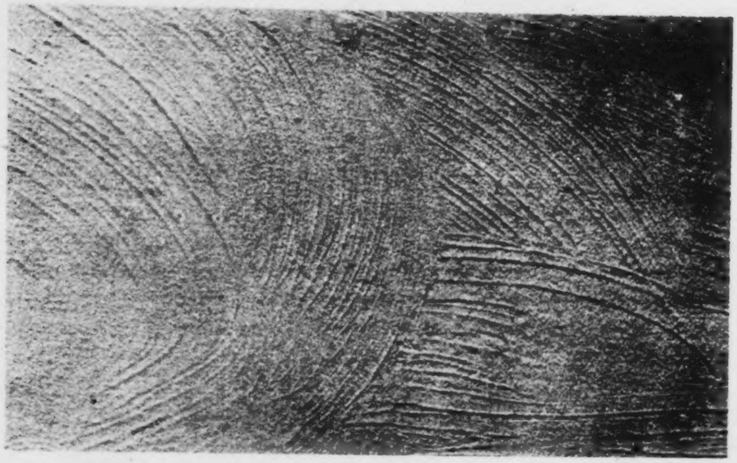
(NOTE: A hand trowel finish defines any type of trowel finish, including very wet.)



INFORMATION SHEET

E. Swirl

(NOTE: This is used for decorative areas.)



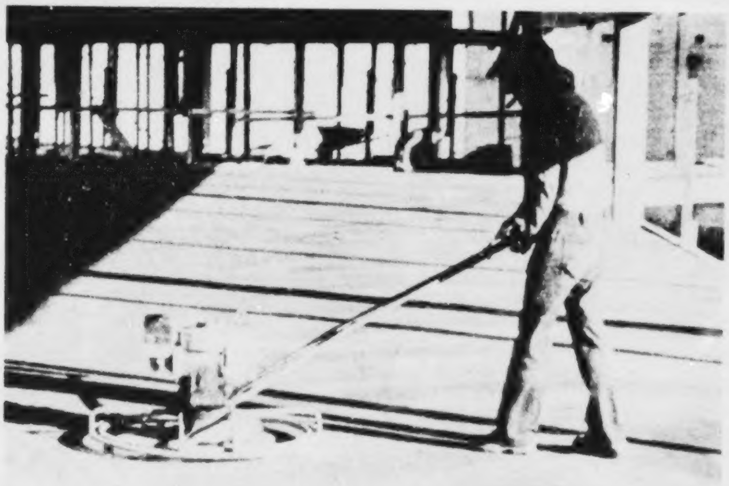
F. Hard trowel or glaze

(NOTE: A hard trowel finish is just as it implies, a hard trowel finish.)

G. Burnish

(NOTE: A burnish finish is a process of troweling concrete to a very hard, smooth finish.)

H. Machine



INFORMATION SHEET

XV. Problems in estimating materials for concrete construction (Assignment Sheet #1)

(NOTE: A rule of thumb is that the yield of a concrete mix will generally be 60% of total volume.)

A. Formula for cubic feet

$$\text{Cubic feet} = \frac{\text{Width (feet)} \times \text{Length (feet)} \times \text{Thickness (inches)}}{12}$$

B. Formula for cubic yards

$$\text{Cubic yards} = \frac{\text{Cubic feet}}{27}$$

OR

$$\text{Cubic yards} = \frac{\text{Width (feet)} \times \text{Length (feet)} \times \text{Thickness (feet)}}{27}$$

Example: How much concrete would be required for 4" floor in a 40' X 72' building?

$$\text{Cubic feet} = \frac{40' \times 72' \times 4''}{12} = 960$$

$$\text{Cubic yards} = \frac{960 \text{ cu ft}}{27} = 35.56$$

$$\text{Cubic yards} = \frac{40' \times 72' \times 1/3'}{27} = 35.56$$

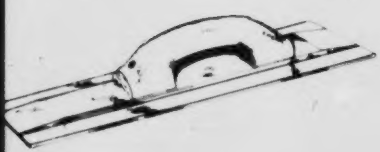
(NOTE: An additional 5% is generally added to calculated value to allow for uneven grade, waste, spillage, or unforeseen factors.)

Concrete Mixing Ratio

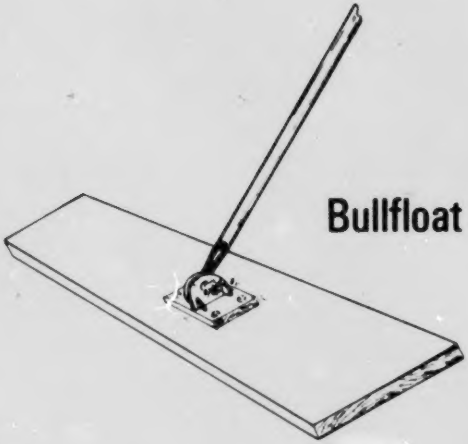
1 : 2 : 3 — 6

Parts (cu ft) of Cement	Parts (cu ft) of Sand	Parts (cu ft) of Aggregate	Gallons of Water

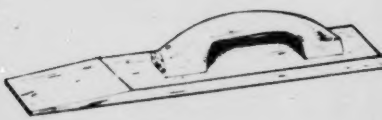
Tools Used in Concrete Work



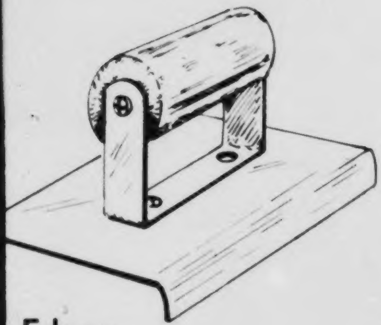
Magnesium Float



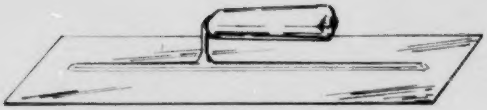
Bullfloat



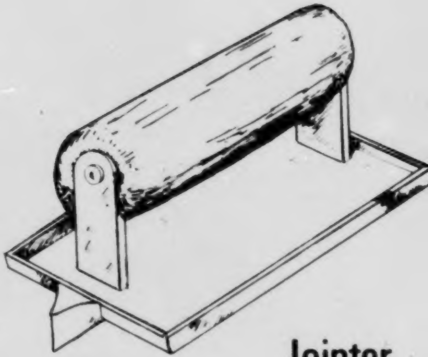
Wood Float



Edger



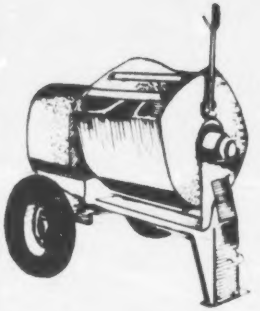
Finishing Trowel



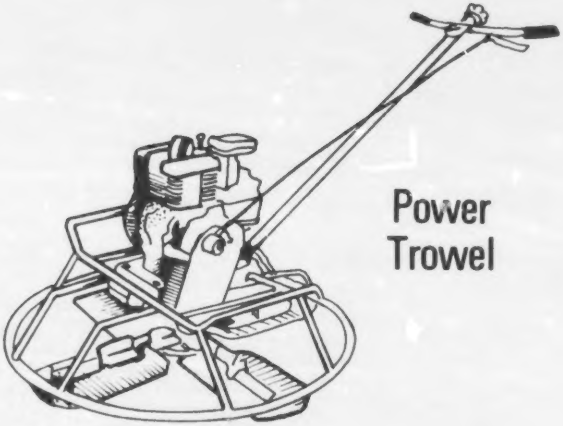
Jointer
or Groover

Tools Used in Concrete Work

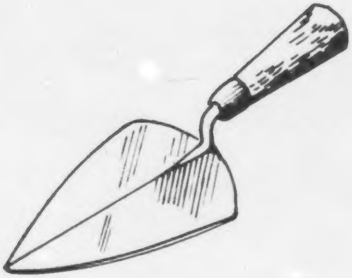
(Continued)



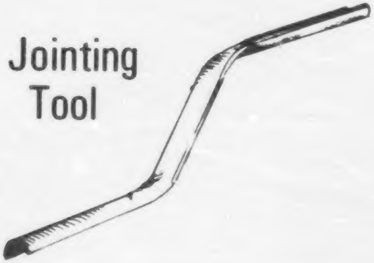
Concrete Mixer



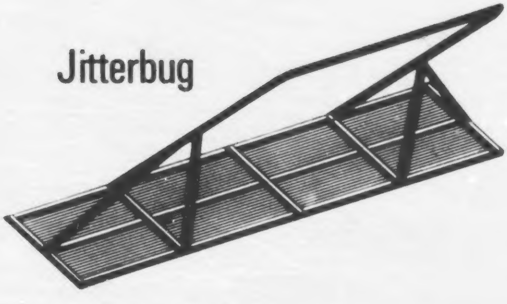
Power Trowel



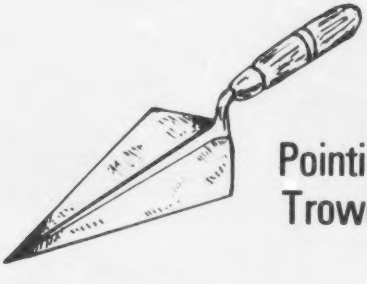
Brick Trowel



Jointing Tool



Jitterbug



Pointing Trowel

CONCRETE
UNIT IV

ASSIGNMENT SHEET #1--ESTIMATING CONCRETE

Calculate the amount of concrete needed for the following problems. Show all work.

1. Calculate the cubic yards of concrete needed for a 15' X 20' X 5" patio.

2. How many cubic yards of concrete will be needed for a drive 45' X 15' X 4"?

3. How much concrete will be needed to pour footing 6" wide X 18" deep in a building 40' X 60'?

CONCRETE
UNIT IV

ANSWERS TO ASSIGNMENT SHEET #1

1. $\frac{15' \times 20' \times 5''}{12} = \frac{1500}{12} = 125$ cu ft

   $\frac{125}{27}$ cu ft = 4.63 cu yd

2. $\frac{45' \times 15' \times 1/3}{27} = \frac{225}{27} = 8.33$ cu yd

3. $\frac{0.5' \times 2(40' + 60') \times 1.5'}{27} = \frac{150}{27} = 5.55$ cu yd

CONCRETE
UNIT IV

TEST

NAME ______________________________ SCORE ____________________

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

_____a. Hard, rock-like mass of sand, gravel, or crushed rock; one of the principle incredients of concrete

_____b. Base upon which a foundation of a building is set

_____c. Finely-ground manufactured product mixed with water to form the paste to make concrete; active ingredient of concrete

_____d. Material added to concrete to increase tensile strength

_____e. Straightedge used to level concrete after being placed in form

_____f. Concrete ingredients are proportioned at central location and blended on way to job; provides concrete that it is ready to use when it arrives at the job site

_____g. Volume formed by a cube having a dimension of three feet on each side

_____h. Artificial stone; composed of a mixture of portland cement, sand, aggregate, and water

_____i. Chemical process that takes place between cement and water

_____j. Process of preventing the evaporation of moisture from concrete

1. Cubic yard
2. Screed
3. Ready-mix concrete
4. Footing
5. Reinforcing
6. Hydration
7. Aggregate
8. Concrete
9. Cement
10. Ready-to-use concrete mix
11. Form
12. Curing

______k. Concrete mix purchased in small amounts (cubic foot bag) with ingredients already mixed in proper proportions

______l. Enclosure made of either wood or metal for holding fresh concrete to the desired shape until it has set and thoroughly dried

2. Select from the list below reasons why concrete is widely used in agriculture. Place an "X" in the appropriate blanks.

______a. Adaptable and serviceable in a variety of situations

______b. Fireproof

______c. Rat, insect, and rodent proof

______d. Economical in installation and maintenance

______e. Less expensive to construct than wood

3. List the ingredients of concrete.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

4. Match types of portland cement on the right to the correct descriptions. The descriptions are continued on the next page.

______a. Low heat portland cement; designed to reduce the amount and rate of heat generated in curing large masses of concrete, such as large dams

______b. Modified portland cement; used where there may be a moderate sulfate attack or concern of heat build-up

______c. Sulfate resistant portland cement; used where concrete will be exposed to water or soil having a high alkali content

1. Type I
2. Type II
3. Type III
4. Type IV
5. Type V

_____d. General purpose cement; called normal portland cement

_____e. High-early-strength portland cement; used to obtain strength in one to three days after casting

5. Identify the meaning of numbers in concrete mixes.

1 : 2 : 3 — 6
a. b. c. d.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

6. Select from the list below factors that determine quality, durability, and strength of concrete. Place an "X" in the appropriate blanks.

_____a. Amount of salt water used

_____b. Proper curing of mixture after it is placed

_____c. Way ingredients are mixed and placed

_____d. Amount of clean water used

_____e. Kind, size, and amount of aggregate used

_____f. Quality and amount of cement used

7. List factors that determine maximum size of aggregate used in concrete.

a. ____________________

____

b. ____________________

____

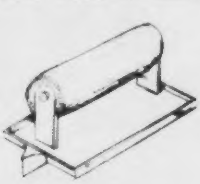
c. ____________________

____

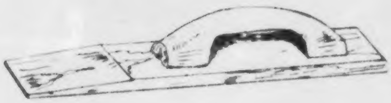
d. ____________________

____

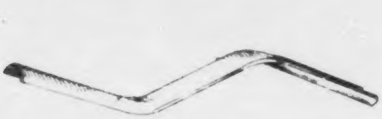
8. Identify tools used in concrete work.



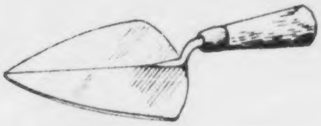
a. ______________________



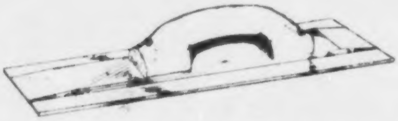
b. ______________________



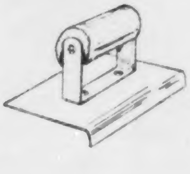
c. ______________________



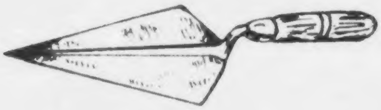
d. ______________________



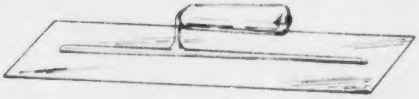
e. ______________________



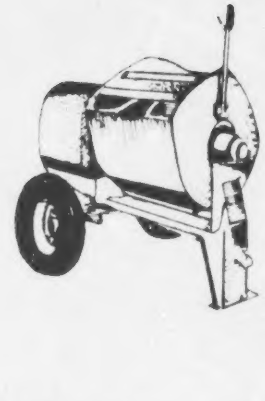
f. ______________________



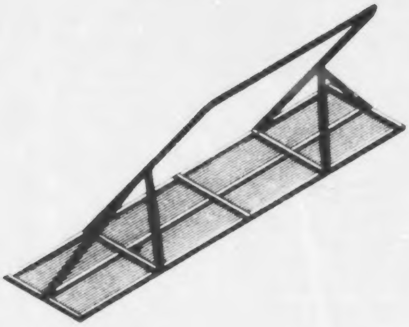
g. ______________________



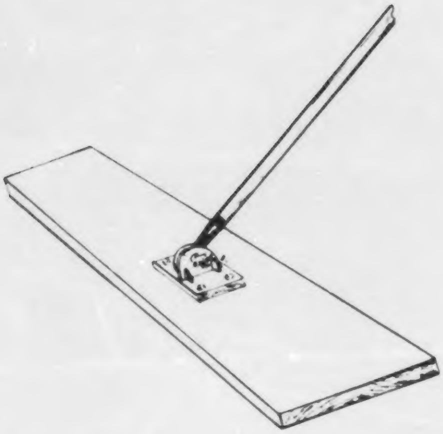
h. ______________________

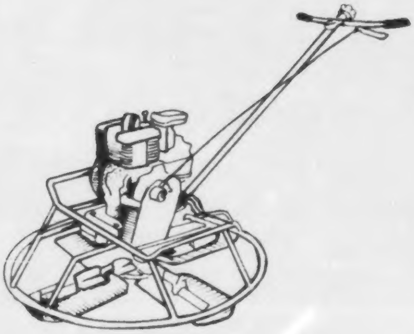


i. ______________________



j. ______________________





k. ____________________ l. ____________________

9. State the effects of proper curing on the quality of finished concrete.

a. ____

b. ____

c. ____

____

10. Arrange in order the procedure for curing concrete. Place a "1" in front of the first step, a "2" in front of the second step, and so on.

_____a. Use jitterbug to compact placed or poured concrete

_____b. Rod concrete to level (using straightedge) as soon as possible after placing or pouring

_____c. Cure for a minimum of three days

_____d. Use proper equipment to give desired finish

_____e. Protect concrete so water will not evaporate too quickly

_____f. Float the slab with a hand float or bullfloat, depending on size of area

_____g. Cover to protect from weather

11. List kinds of reinforcement used in concrete.

a. ______________________________

b. ______________________________

12. Match sizes of reinforcing bars on the right to the bar numbers on the left.

Number		Size
_____a. #4	1.	1/4"
_____b. #8	2.	3/8"
_____c. #2	3.	1/2"
_____d. #6	4.	5/8"
_____e. #3	5.	3/4"
_____f. #7	6.	7/8"
_____g. #5	7.	1"

13. List characteristics of a good form.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

14. Select from the list below types of finishes for concrete floors. Place an "X" in the appropriate blanks.

_____a. Cement paint

_____b. Rough broom

_____c. Hand trowel

_____d. Rubbed

_____e. Burnish

_____f. Sandblast

_____g. Stone

_____h. Swirl

_____i. Float

_____j. Machine

15. Calculate the following problem in estimating materials for concrete construction. Show all work.

Problem: How many cubic yards of concrete will be needed to pour a floor in a barn with the dimensions of 43' X 79' X 4" thick?

CONCRETE
UNIT IV

ANSWERS TO TEST

1. Match terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided. Definitions are continued on the following page.

_7_ a. Hard, rock-like mass of sand, gravel, or crushed rock; one of the principle incredients of concrete

_4_ b. Base upon which a foundation of a building is set

_9_ c. Finely-ground manufactured product mixed with water to form the paste to make concrete; active ingredient of concrete

_5_ d. Material added to concrete to increase tensile strength

_2_ e. Straightedge used to level concrete after being placed in form

_3_ f. Concrete ingredients are proportioned at central location and blended on way to job; provides concrete that it is ready to use when it arrives at the job site

_1_ g. Volume formed by a cube having a dimension of three feet on each side

_8_ h. Artificial stone; composed of a mixture of portland cement, sand, aggregate, and water

_6_ i. Chemical process that takes place between cement and water

_12_ j. Process of preventing the evaporation of moisture from concrete

1. Cubic yard
2. Screed
3. Ready-mix
4. Footing
5. Reinforcing
6. Hydration
7. Aggregate
8. Concrete
9. Cement
10. Ready-to-use concrete mix
11. Form
12. Curing

10 k. Concrete mix purchased in small amounts (cubic foot bag) with ingredients already mixed in proper proportions

11 l. Enclosure made of either wood or metal for holding fresh concrete to the desired shape until it has set and thoroughly dried

2. Select from the list below reasons why concrete is widely used in agriculture. Place an "X" in the appropriate blanks.

X a. Adaptable and serviceable in a variety of situations

X b. Fireproof

X c. Rat, insect, and rodent proof

X d. Economical in installation and maintenance

_____ e. Less expensive to construct than wood

3. List the ingredients of concrete.

a. Portland cement

b. Sand

c. Aggregate

d. Water

4. Match types of portland cement on the right to the correct descriptions. The descriptions are continued on the next page.

4 a. Low heat portland cement; designed to reduce the amount and rate of heat generated in curing large masses of concrete, such as large dams

2 b. Modified portland cement; used where there may be a moderate sulfate attack or concern of heat build-up

5 c. Sulfate resistant portland cement; used where concrete will be exposed to water or soil having a high alkali content

1. Type I
2. Type II
3. Type III
4. Type IV
5. Type V

__1__ d. General purpose cement; called normal portland cement

__3__ e. High-early-strength portland cement; used to obtain strength in one to three days after casting

5. Identify the meaning of numbers in concrete mixes.

   1 : 2 : 3 – 6
   a. b. c. d.

   a. Parts (cu ft) of cement

   b. Parts (cu ft) of sand

   c. Parts (cu ft) of aggregate

   d. Gallons of water

6. Select from the list below factors that determine quality, durability, and strength of concrete. Place an "X" in the appropriate blanks.

   ____ a. Amount of salt water used

   __X__ b. Proper curing of mixture after it is placed

   __X__ c. Way ingredients are mixed and placed

   __X__ d. Amount of clean water used

   __X__ e. Kind, size, and amount of aggregate used

   __X__ f. Quality and amount of cement used

7. List factors that determine maximum size of aggregate used in concrete.

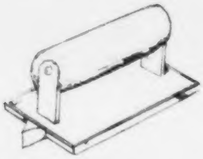
   a. Should be determined by size and shape of concrete member

   b. Should not exceed one-fifth the dimension of nonreinforced slabs on grade

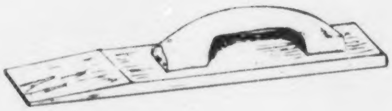
   c. Should not exceed three-fourths the clear spacing between reinforcing bars or between reinforcing bar and form

   d. Should not exceed one-third the depth of nonreinforced slabs on grade

8. Identify tools used in concrete work.

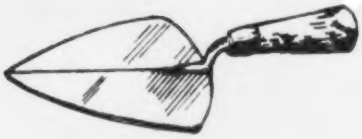


a. Jointer or groover

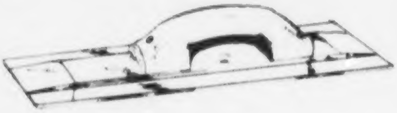


b. Wood float

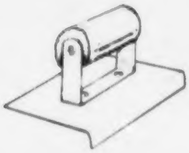
c. Jointing tool



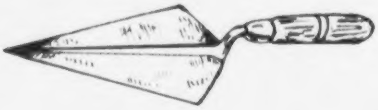
d. Brick trowel



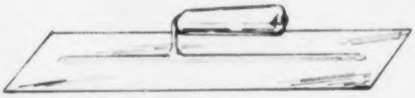
e. Magnesium float



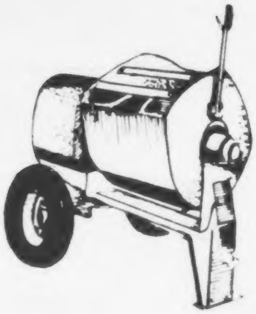
f. Edger



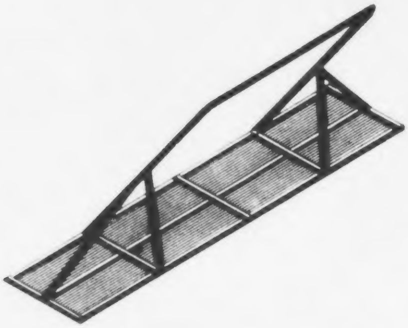
g. Pointing trowel



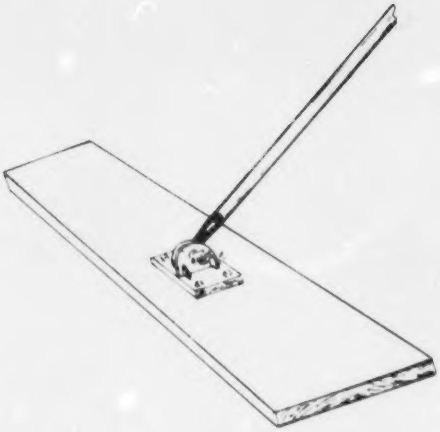
h. Finishing trowel



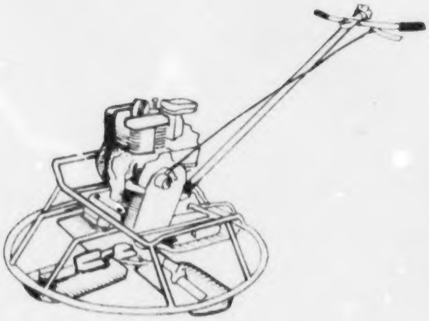
i. Concrete mixer



j. Jitterbug



k. Bullfloat



l. Power trowel

9. State the effects of proper curing on the quality of finished concrete.

   a. Strength is increased very rapidly

   b. Quality is improved

   c. Concrete cured in moist air for two days is 50% stronger than concrete exposed to dry air

10. Arrange in order the procedure for curing concrete. Place a "1" in front of the first step, a "2" in front of the second step, and so on.

    3 a. Use jitterbug to compact placed or poured concrete

    1 b. Rod concrete to level (using straightedge) as soon as possible after placing or pouring

    7 c. Cure for a minimum of three days

    5 d. Use proper equipment to give desired finish

    2 e. Protect concrete so water will not evaporate too quickly

    4 f. Float the slab with a hand float or bullfloat, depending on size of area

    6 g. Cover to protect from weather

11. List kinds of reinforcement used in concrete.

    a. Bar

    b. Welded wire fabric

12. Match sizes of reinforcing bars on the right to the bar numbers on the left.

	Number		Size
3	a. #4	1.	1/4"
7	b. #8	2.	3/8"
1	c. #2	3.	1/2"
5	d. #6	4.	5/8"
2	e. #3	5.	3/4"
6	f. #7	6.	7/8"
4	g. #5	7.	1"

13. List characteristics of a good form.

a. Strong and rigid

b. Smooth finish

c. Easily removed

d. Reuseable

14. Select from the list below types of finishes for concrete floors. Place an "X" in the appropriate blanks.

_____ a. Cement paint

__X__ b. Rough broom

__X__ c. Hand trowel

_____ d. Rubbed

__X__ e. Burnish

_____ f. Sandblast

_____ g. Stone

__X__ h. Swirl

__X__ i. Float

__X__ j. Machine

15. Calculate the following problem in estimating materials for concrete construction. Show all work.

Problem: How many cubic yards of concrete will be needed to pour a floor in a barn with the dimensions of 43' X 79' X 4" thick?

$$\frac{43 \text{ X } 79 \text{ X } 1/3}{27} = \frac{1132.33}{27} = 41.94 \text{ cubic yards}$$

USING THE FARM LEVEL
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to calculate problems while performing different leveling jobs and record the results in a field notebook. The student should be able to demonstrate the ability to set up and adjust the instrument, read the rod, and perform contour and differential leveling. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with using the farm level to the correct definitions.
2. Identify the types of levels.
3. Identify the parts of the farm level.
4. Identify the cross hairs in the telescope.
5. Identify the types of self-reading rods.
6. Match the markings on the farm level to the correct graduations.
7. Read the self-reading rods.
8. Identify the parts of the rod.
9. Match the parts of the rod to their correct uses.
10. Name common errors in measurement.
11. Name rules for care of the farm level.
12. Identify hand motions used by the instrument person to guide the target person.
13. Select from a list points to follow in keeping good field notes.
14. Calculate problems and record the results in the field notebook.
15. Demonstrate the ability to:
    a. Set up and adjust the farm level.
    b. Complete a differential leveling problem.
    c. Complete a profile leveling problem.

USING THE FARM LEVEL
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in the job sheets.

   (NOTE: Have students complete Job Sheets #2 and #3 before attempting Assignment Sheets #3 and #4.)

   G. Assign students a leveling job, such as differential leveling, profile leveling, or run graded or contour lines.

   H. Give test.

II. Unit references:

A. Schwab, Glenn O.; Frevert, Richard K.; Barnes, Kenneth K.; and Edminster, Talcott W. *Elementary Soil and Water Engineering.* New York: John Wiley and Sons, Inc., 1957.

B. Phipps, Lloyd J.; McColly, H. F.; Scranton, L. L.; and Cook, G. C. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc., 1967.

C. *Setting Up the Instrument.* San Luis Obispo: California State Polytechnic College. (Color filmstrip and manual)

D. *Reading the Rod.* San Luis Obispo: California State Polytechnic College. (Color filmstrip and manual)

E. Roth, L. O.; Crow, Frank; and Mahoney, G. W. A. *An Introduction to Agricultural Engineering.* Westport, Connecticut: The AVI Publishing Company, Inc., 1975.

USING THE FARM LEVEL
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Bench mark (BM)--Permanent point of known or assumed elevation from which leveling surveys are started

B. Foresight (FS)--Rod reading taken on a point of unknown elevation

C. Backsight (BS)--Rod reading taken on a point of known elevation

D. Height of instrument (HI)--Elevation of the level line of sight or of the cross hairs in the telescope with respect to the bench mark

E. Turning point (TP)--Solid location, usually a temporary stake, on which a foresight is taken, the instrument moved, and then a backsight taken to determine a new HI

F. Field notebook--Book used to keep surveying information

G. Line of sight--Level line through the instrument, as viewed by the eye; place where vertical hair crosses the horizontal hair

H. Self-reading rod--Rod that is read through the instrument by the instrument person

I. Differential leveling--Method of determining the difference in elevation between two points

J. Profile leveling--Method of determining the elevation of a series of points at measured intervals along a line

K. Contour line--Line connecting points on the land surface which have the same elevation

L. Level rod--Rod used in leveling, normally graduated in tenths and hundredths of a foot

M. Topographic leveling--Process by which the elevation of spaced grid points in a field are determined

N. Error of closure--Difference between original BM1 elevation and the calculated BM1 elevation after a return check, if they fail to agree

Example:
100.00 Original BM1 elevation
99.99 Calculated BM1 elevation
0.01 Error of closure

INFORMATION SHEET

II. Types of levels (Transparency 1)

A. Engineer's dumpy

B. Engineer's wild tilting

C. Turret

(NOTE: This is the level commonly used by farmers.)

D. Engineer's Zeiss

E. Builder's

(NOTE: The builder's level is the most practical and economical for general use and is sufficiently accurate for most purposes.)

III. Parts of the farm level (Transparency 2)

A. Eye piece

B. Focusing screw

C. Sun shade

D. Bubble tube

E. Clamp

F. Slow motion screw

G. Leveling head

H. Head plate

I. Leveling screw

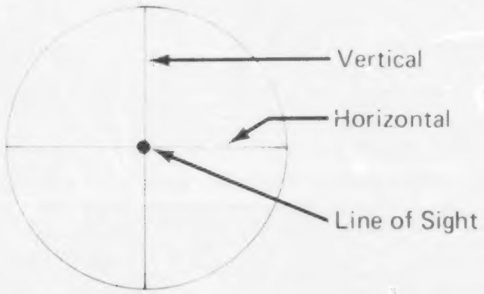
J. Tripod

K. Leg thumb nuts

L. Telescope barrel

INFORMATION SHEET

IV. Cross hairs



- A. Vertical

  (NOTE: This indicates direction.)

- B. Horizontal

  (NOTE: This indicates the flat plane.)

- C. Line of sight

  (NOTE: This is indicated by the cross of the vertical and horizontal hairs.)

V. Self-reading rods (Transparency 3)

- A. Positive reading
- B. Direct reading

VI. Markings and graduations of the farm level (Transparency 4)

- A. Red numbers--Designate feet
- B. Black numbers--Indicate tenths of feet
- C. Black and white marks--Show hundredths of feet
- D. Vernier scale--Reads thousandths of feet

VII. Reading the self-reading rod (Transparency 4, Assignment Sheet #1)

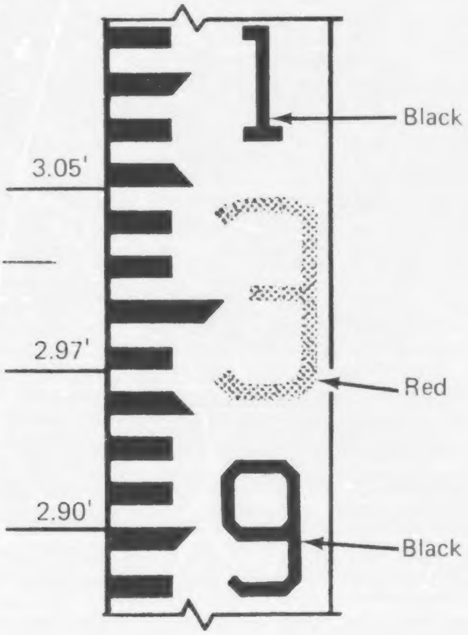
- A. Positive reading--Read from bottom up
- B. Direct reading--Read from top down
- C. Large red numbers are full foot numbers

INFORMATION SHEET

D. Smaller black numbers are 0.1 feet

E. Top and bottom of small black marks are 0.01 feet

Example:



VIII. Parts of the rod (Transparency 5)

A. Target face

B. Target clamp

C. Rod clamp

D. Vernier scale

IX. Parts of the rod and their uses (Transparency 5)

A. Target face--Red and white disc on rod used for certain types of readings

B. Target clamp--Holds the target in place

C. Rod clamp--Holds the rod when extended

D. Vernier scale--Found on target face and rod clamp; enables reading to the nearest thousandths of a foot

X. Common errors in measurement

A. Tape not pulled tight enough

INFORMATION SHEET

- B. Tape not in proper alignment
- C. Plumb bob not used when measuring on slope
- D. Reading or recording the wrong numbers

XI. Care of farm level

- A. Protect against shock and vibration during transport
- B. Keep in box except when in use
- C. Place lens and tripod cap in box after removing from instrument
- D. Attach instrument onto tripod carefully and firmly before moving tripod

  (NOTE: Never force screws or other moving parts of an instrument.)
- E. Always use sun shade regardless of the weather
- F. Clean lenses with soft tissue

  (CAUTION: Do not clean with fingers or rough cloth. Do not remove lenses.)
- G. Do not set up instrument in the shade and move to sun without releasing adjusting screws

XII. Hand motions (Transparency 6)

- A. Move in this direction
- B. Move up
- C. Move down
- D. Turning point
- E. Observation completed; move on; understood
- F. Come in
- G. Wrong face; check clamp; rod upside down
- H. Use long rod
- I. Wave rod from side to side

INFORMATION SHEET

XIII. Keeping good field notes

A. Reserve first few pages for index

B. Number pages in upper right-hand corner

(NOTE: The double page is considered one page.)

C. Write descriptive title at top of first page for each job

(NOTE: This title should be printed and should show the type of survey, legal description, and name of farm.)

D. Record names of survey party at top of right-hand side

(NOTE: Job assigned to each should be recorded.)

Example: Instrument is designated by ⊼ ; rod person by 0; recorder by REC; rear chain person by RC; head chain person by HC

E. Use 3H or 4H hard-lead pencils

(NOTE: Never use ink in keeping field notes.)

F. Record numbers and letters in the best form possible

G. Do not erase

(NOTE: If a mistake is made, mark through and record above.)

XIV. Calculating surveying problems (Assignment Sheets #2, #3, and #4)

A. Start with known BM1

(NOTE: This bench mark is usually used as 100.00 elevation.)

B. BS + last known elevation = HI

C. HI - FS = Elevation

D. Difference between total of BS and total of FS should equal the difference between the starting elevation and the last elevation

(NOTE: This will determine the degree of error or error of closure.)

INFORMATION SHEET

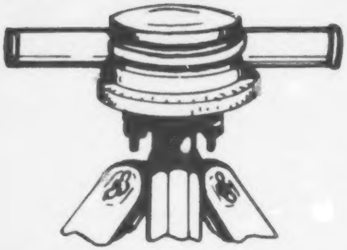
STA	BS	HI	FS	ELEV
BMI	3.00			100.00
		103.00		
TPI	4.00		8.50	94.50
		98.50		
BM2	5.00		6.00	92.50
		97.50		
TPI	8.00		3.00	94.50
		102.50		
BMI			2.50	100.00

ΣBS = 20.00 ΣFS = 20.00

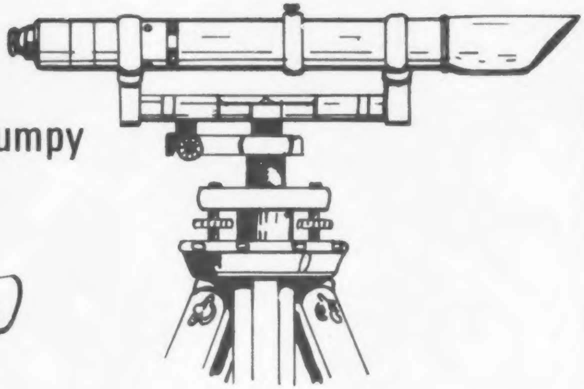
Error of closure = 20.00 - 20.00 = 0.00

= 100.00 - 100.00 = 0.00

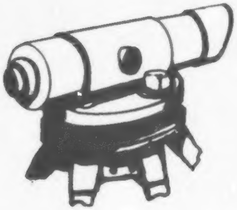
Types of Levels



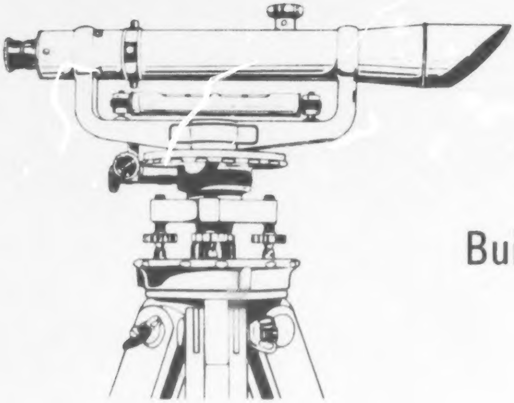
Turret



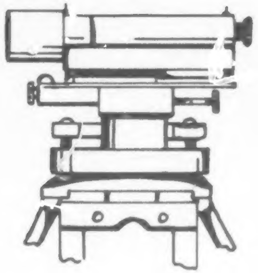
Engineer's Dumpy



Engineer's Zeiss

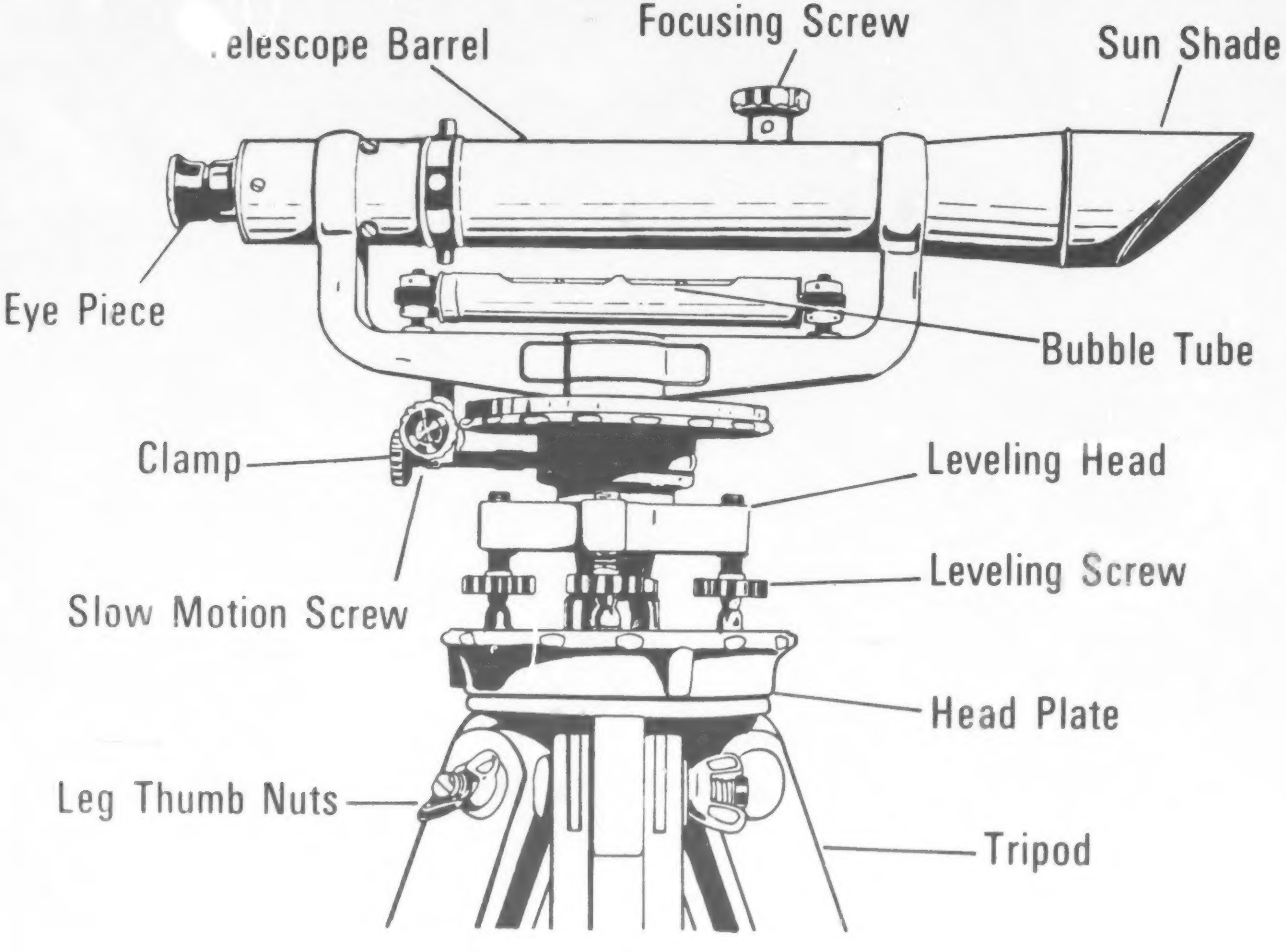


Builder's

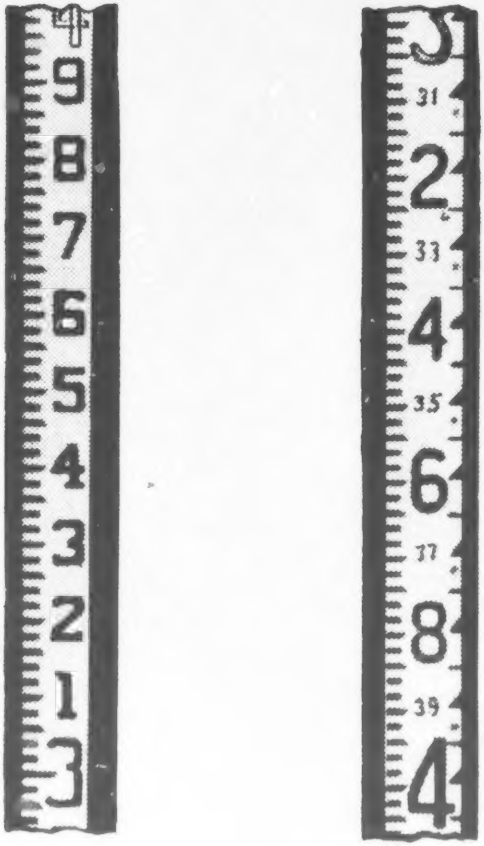


Engineer's Wild Tilting

Parts of the Level


elescope Barrel
Focusing Screw
Sun Shade
Eye Piece
Bubble Tube
Clamp
Leveling Head
Leveling Screw
Slow Motion Screw
Head Plate
Leg Thumb Nuts
Tripod

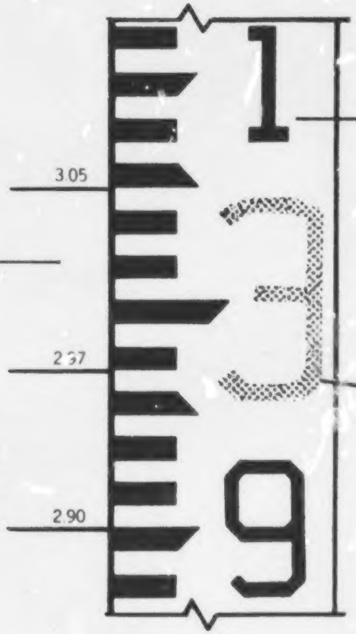
Self-Reading Rods


4
9
8
7
6
5
4
3
2
1
3
3
31
2
33
4
35
6
37
8
39
4

Positive
↑
Reading

Direct
↓
Reading

Reading the Rod



Hundredths of Feet

(Black and White)

Tenths of Feet

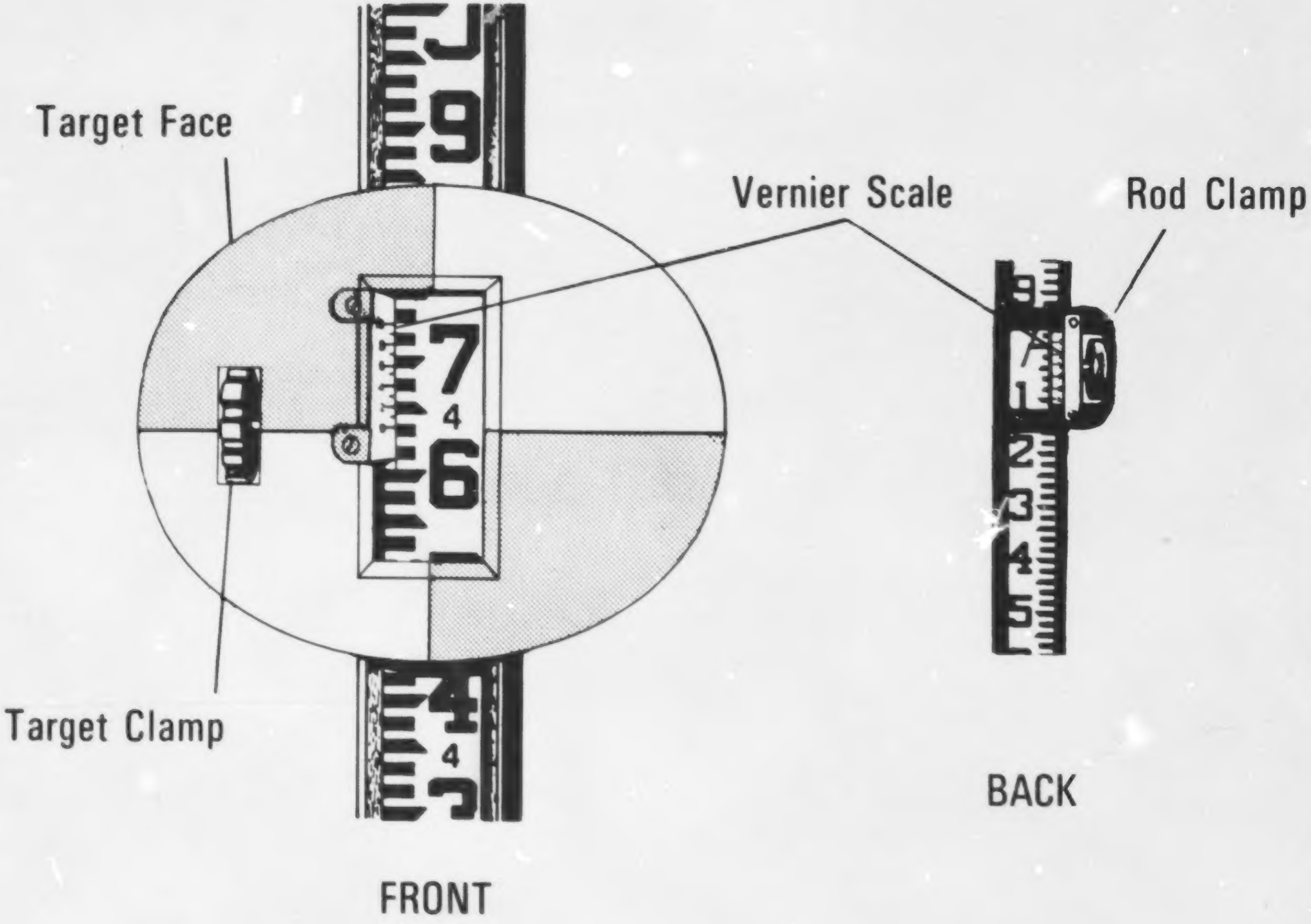
(Black)

Full Foot Numbers

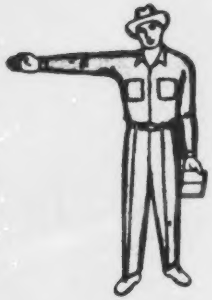
(Red)

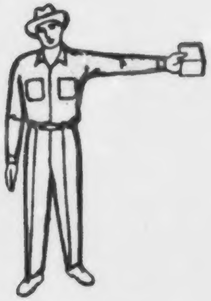
NOTE: Vernier scale reads thousandths of feet

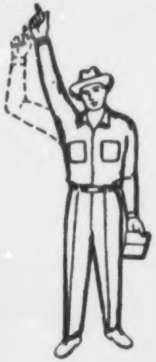
Parts of the Rod

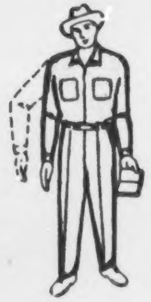

Target Face
Vernier Scale
Rod Clamp
Target Clamp
BACK
FRONT

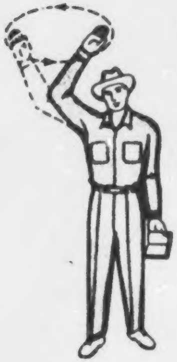
Hand Motions

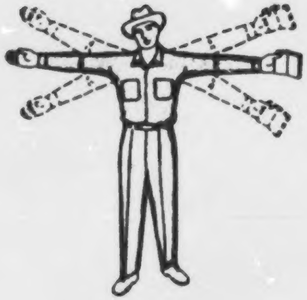

Move Rod to
the Right

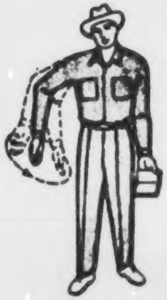

Move Rod to
the Left

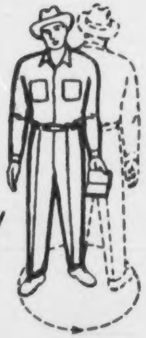

Move Up

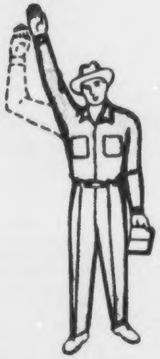

Move Down

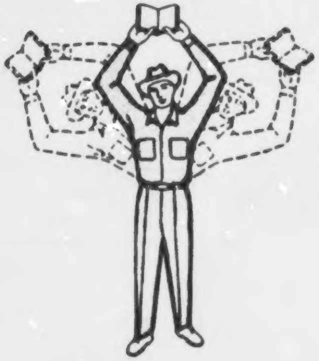

Turning Point


Observation Completed
or Move On
or Understood


Come In


Step Away from Inst.
Walk in Tight Circle
Wrong Face
or Check Clamp
or Rod Upside Down

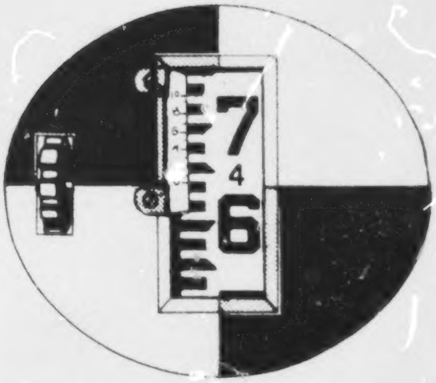

Use
Long Rod

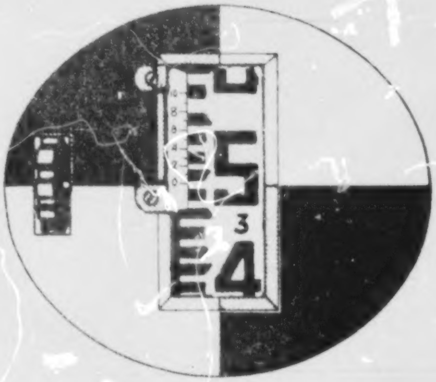

Wave Rod from
Side to Side

USING THE FARM LEVEL
UNIT I

ASSIGNMENT SHEET #1--READ THE SELF-READING ROD

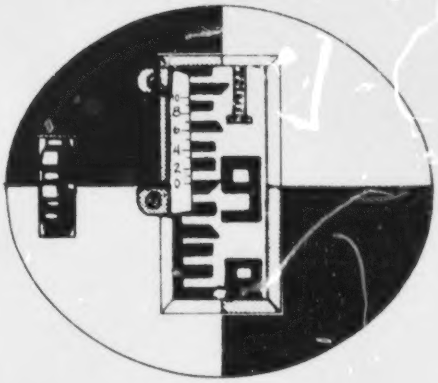
Read each of the illustrations below and record your results in the blanks provided.

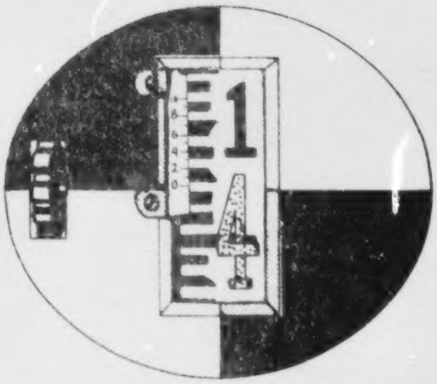




a. ______________________

b. ______________________





c. ______________________

d. ______________________

USING THE FARM LEVEL
UNIT I

ASSIGNMENT SHEET #2--CALCULATE FIELD DATA AND RECORD IN FIELD NOTEBOOK FORM

You have finished surveying a job and the following data was revealed.

BM1	BS	1.21	Elevation was 50.00
TP1	BS	6.20	FS 4.65
TP2	BS	4.82	FS 3.11
TP3	BS	3.03	FS 5.22
BM2			FS 3.16

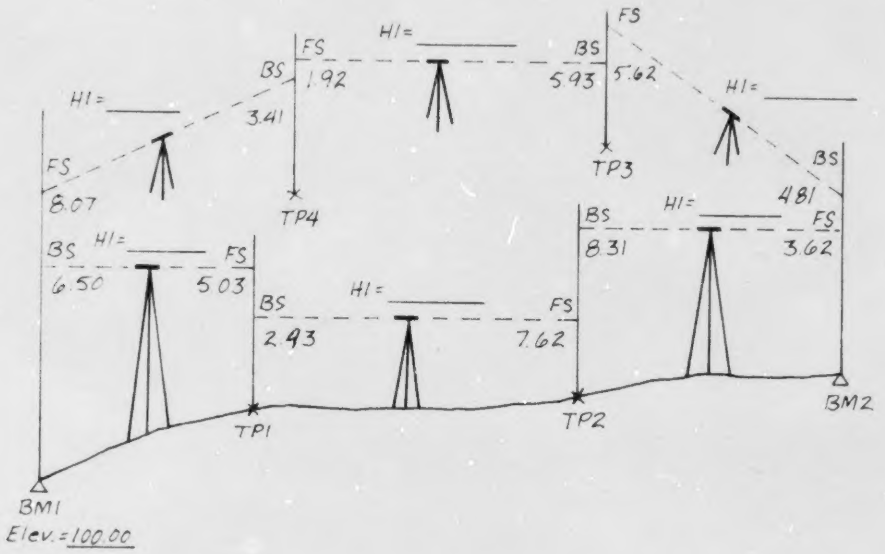
Using the data given, determine the elevation of BM2 and error.

STA	BS	HI	FS	ELEV

USING THE FARM LEVEL
UNIT I

ASSIGNMENT SHEET #3--DIFFERENTIAL LEVELING PROBLEM

Using the following readings, complete the field notes on the form below.


HI = ____
FS
8.07
BS
3.41
FS
1.92
HI = ____
BS
5.93
FS
5.62
HI = ____
BS
4.81
TP4
TP3
BS
6.50
HI = ____
FS
5.03
BS
2.43
HI = ____
FS
7.62
BS
8.31
HI = ____
FS
3.62
TP1
TP2
BM2
BM1
Elev. = 100.00

STA	BS	HI	FS	ELEV
BM1				
TP1				
TP2				
BM2				
TP3				
TP4				
BM1				

ΣBS= _____ ΣFS= _____

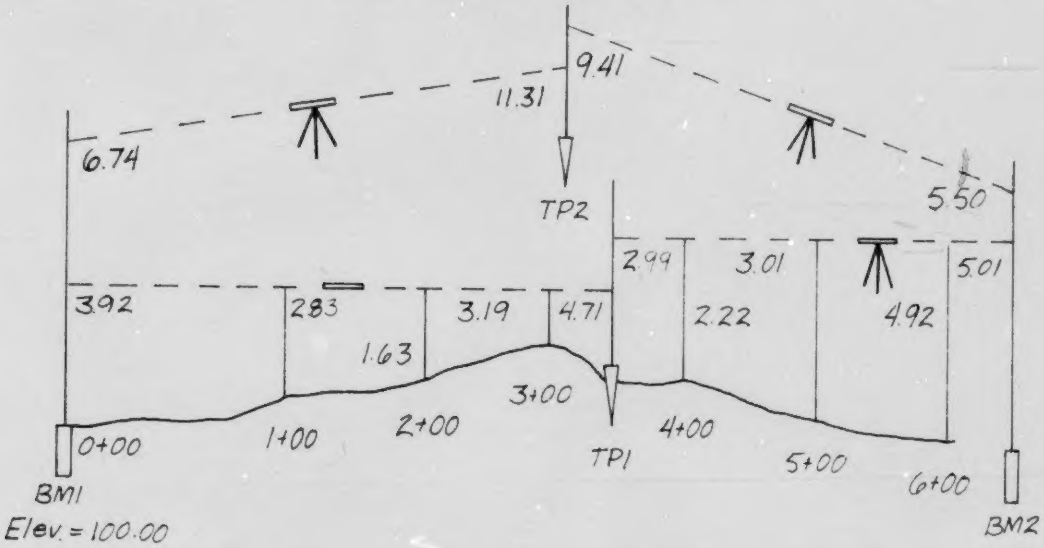
ΣFS-ΣBS= _____ - _____ = _____

CHECK: $\text{BM1}_{(\text{Begin})}$ - $\text{BM1}_{(\text{End})}$ = _____ - _____ = _____

USING THE FARM LEVEL
UNIT I

ASSIGNMENT SHEET #4--PROFILE LEVELING PROBLEM

Using the readings for profile leveling, complete a set of field notes on the form below.


9.41
11.31
6.74
TP2
5.50
2.99
3.01
5.01
3.92
2.83
3.19
4.71
2.22
4.92
1.63
3+00
0+00
1+00
2+00
TP1
4+00
5+00
6+00
BM1
Elev. = 100.00
BM2

STA	BS	HI	FS	ELEV

USING THE FARM LEVEL
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

STA	BS	HI	FS	ELEV
BM1	1.21			50.00
		51.21		
TP1	6.20		4.65	46.56
		52.76		
TP2	4.82		3.11	49.65
		54.47		
TP3	3.03		5.22	49.25
		52.28		
BM2			3.16	49.12

$\Sigma BS = 15.26$ $\Sigma FS = 16.14$

$16.14 - 15.26 = 0.88$ $50.00 - 49.12 = 0.88$

Error = 0.88

Assignment Sheet #2

a. 4.64

b. 3.49

c. 0.90

d. 4.05

Assignment Sheet #3

STA	BS	HI	FS	ELEV
BM1	6.50			100.00
		106.50		
TP1	2.93		5.03	101.47
		104.40		
TP2	8.31		7.62	96.78
		105.09		
BM2	4.81		3.62	101.47
		106.28		
TP3	5.93		5.62	100.66
		106.59		
TP4	3.41		1.92	104.67
		108.08		
BM1			8.07	100.01

ΣBS = 31.89 ΣFS = 31.88

ΣBS - ΣFS = 31.89 - 31.88 = 0.01

CHECK: $\text{BM1}_{(\text{Begin})}$ - $\text{BM1}_{(\text{End})}$ = 100.01 - 100.00 = 0.01

Assignment Sheet #4

STA	BS	HI	FS	ELEV
BM1 0+00	3.92	103.92		100.00
1+00			2.83	101.09
2+00			1.63	102.29
3+00			3.19	100.73
TP1	2.99	102.20	(4.71)	99.21
4+00			2.22	99.98
5+00			3.01	99.13
6+00			4.92	97.28
BM2	5.50	102.69	(5.01)	97.19
TP2	11.31	104.59	(9.41)	93.28
BM1			(4.62)	99.97

ΣBS = 23.72 ΣFS = 23.75

Error of closure = 23.75 - 23.72 = 0.03

100.00 - 99.97 = 0.03

USING THE FARM LEVEL
UNIT I

JOB SHEET #1--SET UP AND ADJUST THE FARM LEVEL

I. Tools and equipment

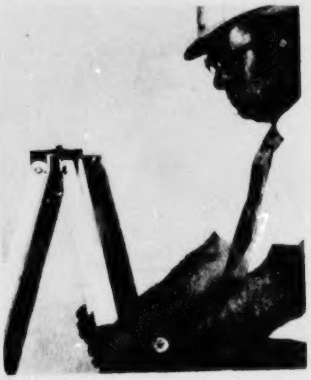
   A. Instrument

   B. Tripod

II. Procedure

   A. Grasp the two legs of the tripod that are nearest you and set the leg shoes in the ground about three feet apart (Figure 1)

FIGURE 1



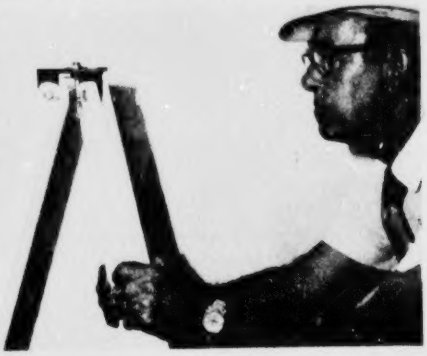
   B. Swing third leg out to form a triangle

   (NOTE: If the ground is not level, you may have to change position of tripod in order to keep head plate level. Always place two legs on downhill or unlevel side.)

   C. Tighten leg thumb nuts

   D. Check head plate to see if it is level (Figure 2)

FIGURE 2

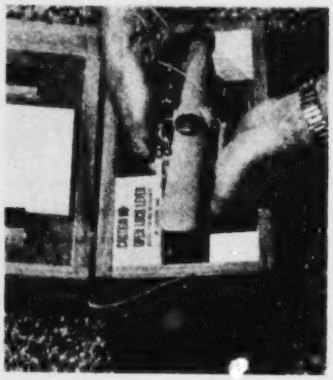


JOB SHEET #1

E. Remove instrument from carrying base by lifting the level bar (Figure 3)

(CAUTION: Never grasp the telescope barrel while removing instrument from carrying case.)

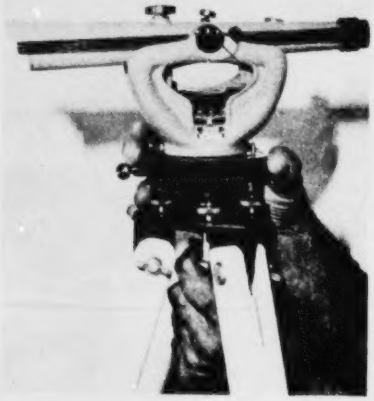
FIGURE 3



F. Attach instrument to head plate by screwing it down (Figure 4)

(CAUTION: Keep a firm grip on instrument until it is securely in position on tripod.)

FIGURE 4



G. Remove dust cap from front lens

(NOTE: The dust cap should be kept in place in order to protect the lens from dust or scratches.)

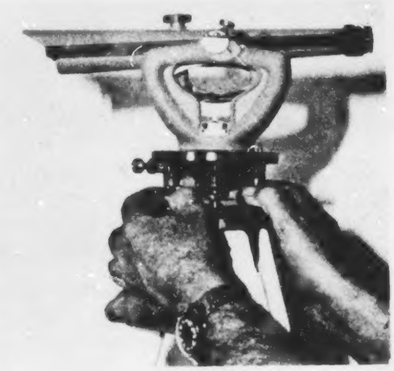
H. Attach sun shade to the instrument

JOB SHEET #1

I. Align telescope barrel directly over one pair of leveling screws (Figure 5)

(NOTE: The leveling screws will be used just as the name indicates, to level the instrument.)

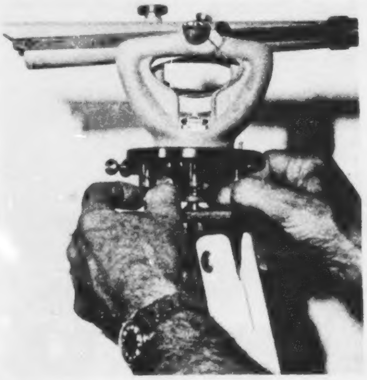
FIGURE 5



J. Rotate screws under the leveling head to bring bubble to the center of the leveling tube (Figure 6)

(NOTE: Move your thumbs in opposite directions.)

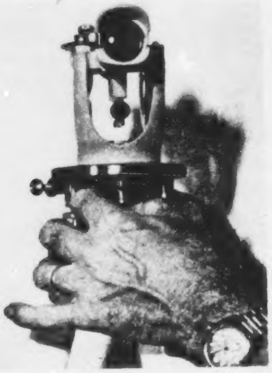
FIGURE 6



K. Check bubble to see if it is centered

L. Turn instrument clockwise through 90 degrees to align with the other pair of leveling screws (Figure 7)

FIGURE 7



JOB SHEET #1

M. Bring bubble to center of marks by rotating leveling screws

N. Turn instrument clockwise through 90 degrees to bring it parallel with first pair of leveling screws

O. Center bubble again

P. Turn instrument clockwise through 90 degrees to bring it parallel with second pair of leveling screws

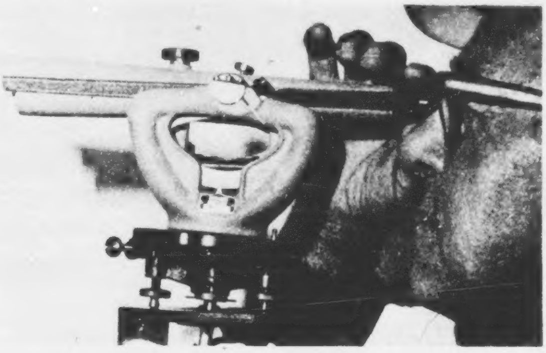
Q. Center bubble again

(NOTE: Bubble should stay in center regardless of what direction the telescope is pointing. If bubble does not, instrument is out of level and should be adjusted by competent personnel.)

R. Focus cross hairs so that they appear sharp and clear (Figure 8)

(NOTE: Focusing is accomplished by looking through the eye piece and by turning the eye piece ring until the cross hairs become sharp or "clear.")

FIGURE 8



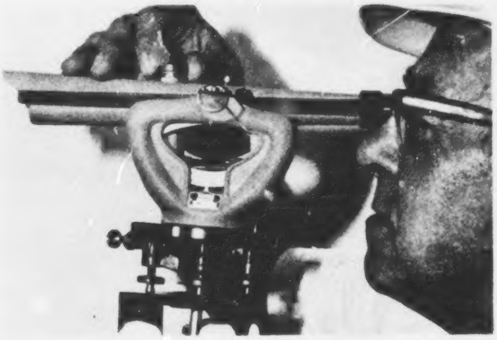
S. Be sure cross hairs are focused

(NOTE: The target may not be in focus.)

JOB SHEET #1

T. Rotate the focusing screw to bring target into sharp focus (Figure 9)

FIGURE 9



(NOTE: When cross hairs and target are in sharp focus, you should be able to read a rod accurately. Always tie level shots back to starting bench mark to check for error in rod shots or in field notes.)

(CAUTION: After instrument is level, keep hands off tripod. Use the instrument only. If instrument creeps off level or is bumped, stop, reset tripod, relevel instrument, and start again from last known good bench mark.)

USING THE FARM LEVEL
UNIT I

JOB SHEET #2--COMPLETE A DIFFERENTIAL LEVELING PROBLEM

I. Tools and equipment

- A. Instrument
- B. Tripod
- C. Rod
- D. Field note paper

II. Procedure

- A. Set up instrument
- B. Establish bench mark (BM1)

  (NOTE: Instructor should designate starting point.)

- C. Take backsight (BS) reading on bench mark
- D. Record reading in field notes (Figure 1)

  (NOTE: Assume starting elevation is 100.00. Be sure to read rod to two decimal places.)

FIGURE 1

STA	BS	HI	FS	ELEV
BM1	3.01			100.00
		103.01		

(NOTE: Backsight is added to elevation to obtain height of instrument.)

- E. Establish turning point (TP1)
- F. Take foresight reading

JOB SHEET #2

G. Record reading in field notes (Figure 2)

FIGURE 2

STA	BS	HI	FS	ELEV
BM1	3.01			100.00
		103.01		
TP1	2.60		3.86	99.15
		101.75		

1 Obtain HI between BM1 and TP1 by adding BS to elevation

Example: 3.01 + 100.00 = 103.01

2. Obtain elevation at TP1 by subtracting FS from HI between BM1 and TP1

Example: 103.01 - 3.86 = 99.15

3. Obtain HI between TP1 and TP2 by adding BS at TP1 to elevation at TP1

Example: 99.15 + 2.60 = 101.75

H. Move instrument and set up again

I. Take backsight reading at TP1 and record in notes

J. Move rod to TP2 and take foresight reading

K. Record in notes (Figure 3)

FIGURE 3

STA	BS	HI	FS	ELEV
BM1	3.01			100.00
		103.01		
TP1	2.60		3.86	99.15
		101.75		
TP2	4.22		4.53	97.22

L. Move instrument and set up again

M. Take backsight on TP2 and record in notes

N. Move rod to BM2 and take foresight reading

JOB SHEET #2

O. Record reading in field notes (Figure 4)

FIGURE 4

STA	BS	HI	FS	ELEV
BM1	3.01			100.00
		103.01		
TP1	2.60		3.86	99.15
		101.75		
TP2	4.22		4.53	97.22
		101.44		
BM2	6.43		6.16	95.28

P. Repeat steps through TP3 and TP4 back to BM1

(NOTE: Completed field notes should look similar to Figure 5.)

STA	BS	HI	FS	ELEV
BM1	3.01			100.00
		103.01		
TP1	2.60		3.86	99.15
		101.75		
TP2	4.22		4.53	97.22
		101.44		
BM2	6.43		6.16	95.28
		101.71		
TP3	3.85		4.44	97.27
		101.12		
TP4	5.11		2.96	98.16
		103.27		
BM1			3.30	99.97

$\Sigma BS = \underline{25.22} \qquad \Sigma FS = \underline{25.25}$

$\underline{\Sigma FS - \Sigma BS} = \overline{25.25} - \underline{25.22} = \underline{0.03}$

CHECK: $BM1_{(Begin)} - BM1_{(End)}$

$\underline{100.00} - \underline{99.97} = \underline{0.03}$

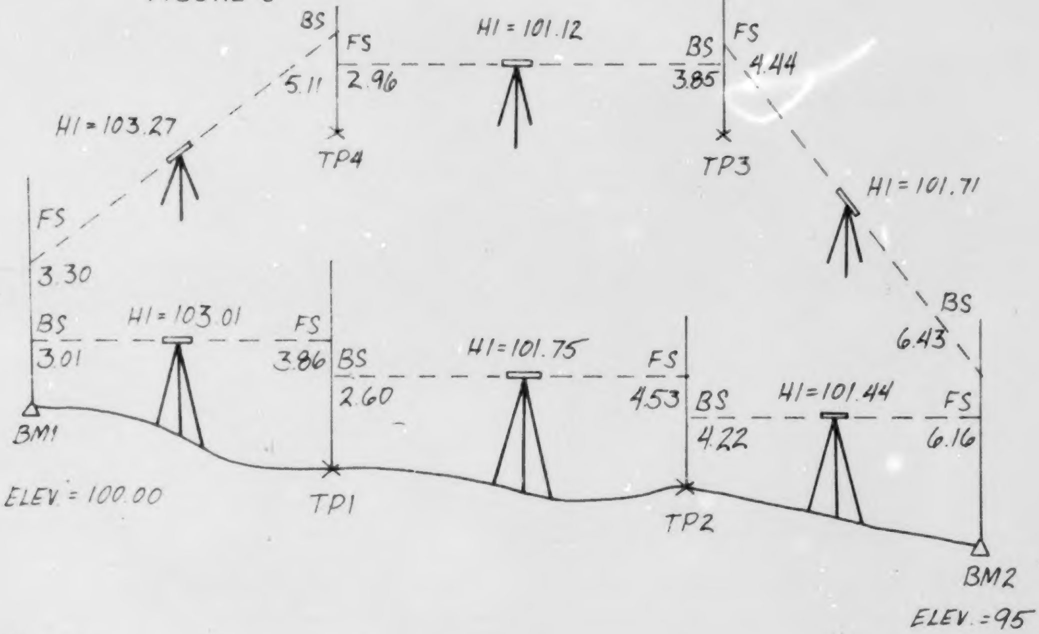
CHECK

JOB SHEET #2

Q. Determine error of closure

(NOTE: Differential leveling problem should have looked similar to Figure 6. For additional practice in recording field notes, see Assignment Sheet #3.)

FIGURE 6


BS
5.11
FS
2.96
TP4
HI = 101.12
BS
3.85
FS
4.44
TP3
HI = 103.27
HI = 101.71
FS
3.30
BS
3.01
HI = 103.01
FS
3.86
BS
2.60
HI = 101.75
FS
4.53
BS
4.22
HI = 101.44
BS
6.43
FS
6.16
BM1
ELEV. = 100.00
TP1
TP2
BM2
ELEV. = 95

USING THE FARM LEVEL
UNIT I

JOB SHEET #3--COMPLETE A PROFILE LEVELING PROBLEM

I. Tools and equipment

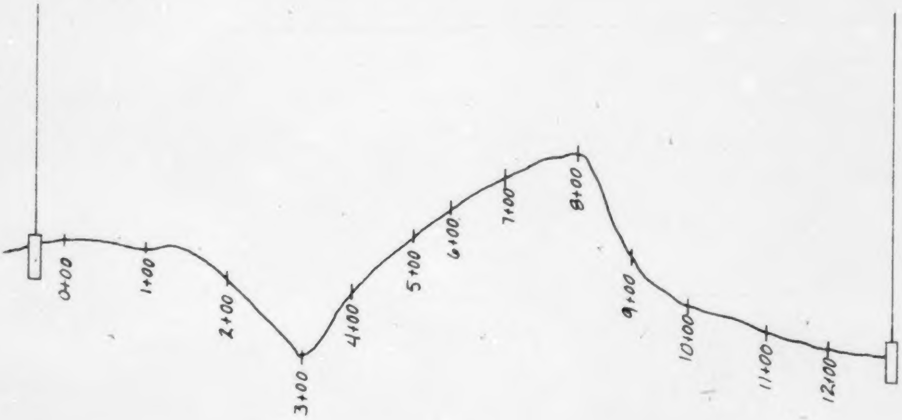
- A. Instrument
- B. Rod
- C. Tape, 100 ft steel
- D. Field note paper
- E. Pencil
- F. Stakes, 2" x 2" x 12"

II. Procedure

- A. Establish center line of area to be profiled
- B. Set stakes at a fixed distance along line (Figure 1)

  (NOTE: Common distances may be 25', 50', or 100' depending on irregularity of ground.)

FIGURE 1



- C. Set up instrument
- D. Take BS reading on BM1 and record in field notes

  (NOTE: Description of location of BM1 should be recorded in right hand column of notes.)

JOB SHEET #3

E. Move rod to first stake designated as 0+00 or starting point of profile and take a foresight reading

(NOTE: All readings at stake location will be recorded as FS readings until a TP is established.)

F. Continue readings at stakes and record as FS readings until it is necessary to move the instrument

G. Establish a turning point before moving instrument

H. Move instrument and set up

I. Take BS on TP1 and record in field notes

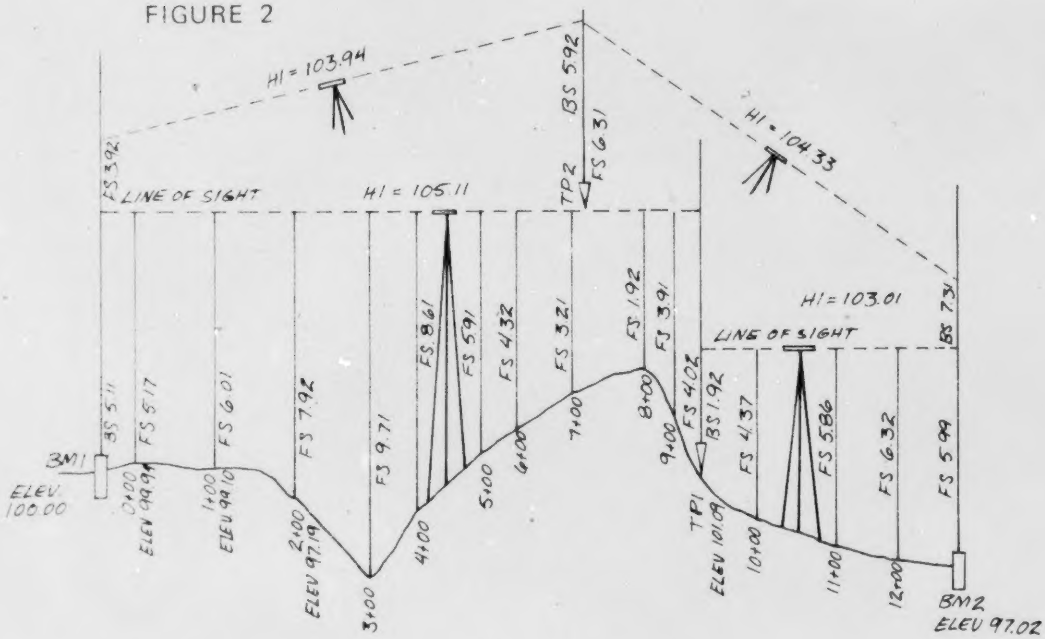
J. Take FS readings at stake until profile is complete or it is necessary to establish another turning point and move the instrument

K. Continue until BM2 is reached

L. Make a return check to BM1

(NOTE: See sample problem in Figure 2 and sample field notes in Figure 3 for a profile leveling exercise. For a practice exercise, complete Assignment Sheet #4.)

FIGURE 2


HI = 103.94
FS 3.92
LINE OF SIGHT
HI = 105.11
BS 5.92
FS 6.31
TP2
HI = 104.33
HI = 103.01
LINE OF SIGHT
BS 7.31
BS 5.11
FS 5.17
FS 6.01
FS 7.92
FS 9.71
FS 8.61
FS 5.91
FS 4.32
FS 3.21
FS 1.92
FS 3.91
FS 4.02
BS 1.92
FS 4.37
FS 5.86
FS 6.32
FS 5.99
BM1
ELEV 100.00
0+00
ELEV 99.94
1+00
ELEV 99.10
2+00
ELEV 97.19
3+00
4+00
5+00
6+00
7+00
8+00
9+00
TP1
ELEV 101.09
10+00
11+00
12+00
BM2
ELEV 97.02

JOB SHEET #3

PROFILE LEVELING South 40 acres					Jan. 15, 1977 Braker Fair, clear, calm farm
STA	BS	HI	FS	ELEV	Comments
BM1	5.11	105.11		100.00	Stake in SE corner
0+00			5.17	99.94	
1+00			6.01	99.10	
2+00			7.92	97.19	
3+00			9.71	95.40	
4+00			8.61	96.50	
5+00			5.91	99.20	
6+00			4.32	100.79	
7+00			3.21	101.90	
8+00			1.92	103.19	
9+00			3.91	101.20	
TP1	1.92	103.01	(4.02)	101.09	Top of stake
10+00			4.37	98.64	
11+00			5.86	97.15	
12+00			6.32	96.69	
BM2	7.31	104.33	(5.99)	97.02	
TP2	5.92	103.94	(6.31)	98.02	
BM1			(3.92)	100.02	

$\Sigma BS = 20.26$ $\Sigma FS = 20.24$

Error of closure: 20.26 - 20.24 = 0.02

100.02 - 100.00 = 0.02

(NOTE: To determine error of closure total all BS then total all FS at TP or BM. In recording field notes, the FS at TP or BM should be in parentheses.)

USING THE FARM LEVEL
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

_____a. Elevation of the level line of sight or of the cross hairs in the telescope with respect to the bench mark

_____b. Level line through the instrument, as viewed by the eye; place where vertical hair crosses the horizontal hair

_____c. Method of determining the difference in elevation between two points

_____d. Permanent point of known or assumed elevation from which leveling surveys are started

_____e. Book used to keep surveying information

_____f. Rod reading taken on a point of known elevation

_____g. Rod used in leveling, normally graduated in tenths and hundredths of a foot

_____h. Solid location, usually a temporary stake, on which a foresight is taken, the instrument moved, and then a backsight taken to determine a new HI

_____i. Process by which the elevation of spaced grid points in a field are determined

_____j. Method of determining the elevation of a series of points at measured intervals along a line

_____k. Rod reading taken on a point of unknown elevation

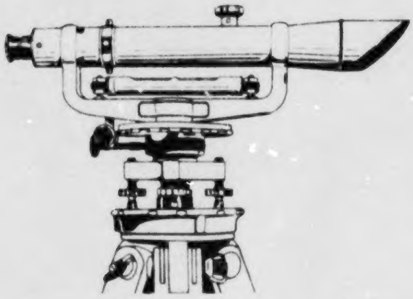
_____l. Rod that is read through the instrument by the instrument person

1. Bench mark (BM)
2. Foresight (FS)
3. Backsight (BS)
4. Height of instrument (HI)
5. Turning point (TP)
6. Field notebook
7. Line of sight
8. Self-reading rod
9. Differential leveling
10. Profile leveling
11. Topographic leveling
12. Level rod
13. Contour line
14. Error of closure

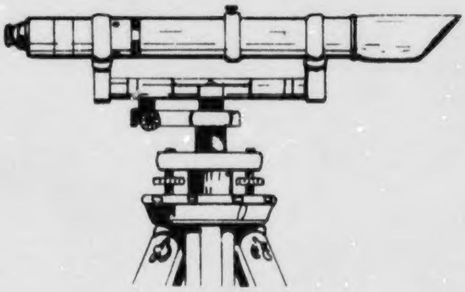
______m. Line connecting points on the land surface which have the same elevation

______n. Difference between original BM1 elevation and the calculated BM1 elevation after a return check, if they fail to agree

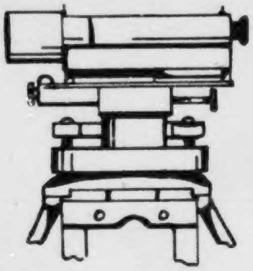
2. Identify the following types of levels.



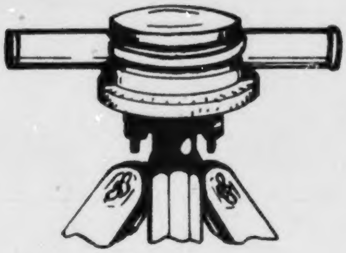
a. ______________________



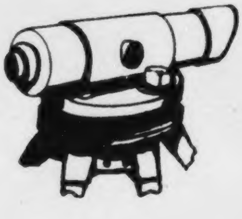
b. ______________________



c. ______________________

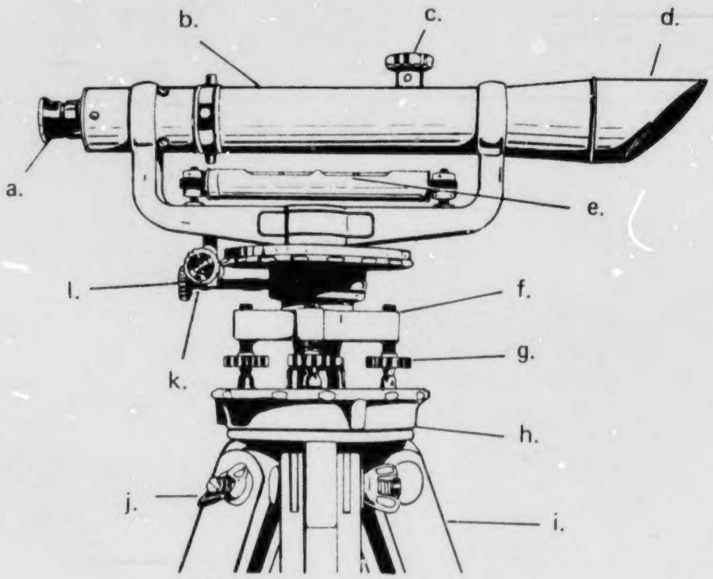


d. ______________________



e. ______________________

3. Identify the parts of the farm level.


b.
c.
d.
a.
e.
l.
f.
k.
g.
h.
j.
i.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

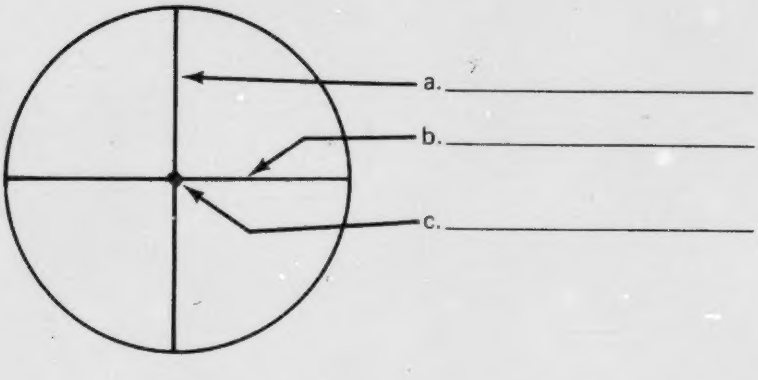
i. ____________________

j. ____________________

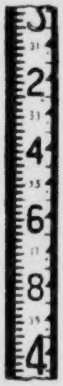
k. ____________________

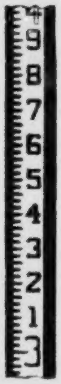
l. ____________________

4. Identify the cross hairs in the telescope.



5. Identify the following types of self-reading rods.



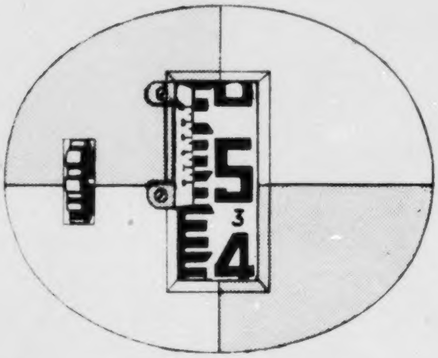


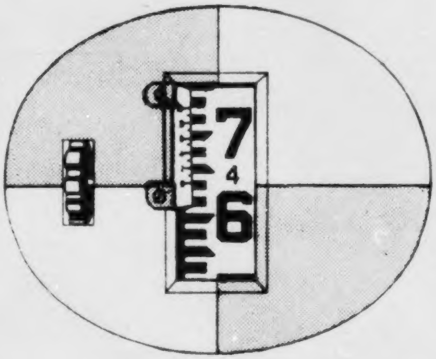
a. __________ ___________   b. ______________________

6. Match the markings on the farm level on the right to the correct graduations on the left. Place the appropriate numbers in the blanks provided.

______a. Designate feet	1. Red numbers
______b. Reads thousandths of feet	2. Black numbers
______c. Indicate tenths of feet	3. Black and white marks
______d. Show hundredths of feet	4. Vernier scale

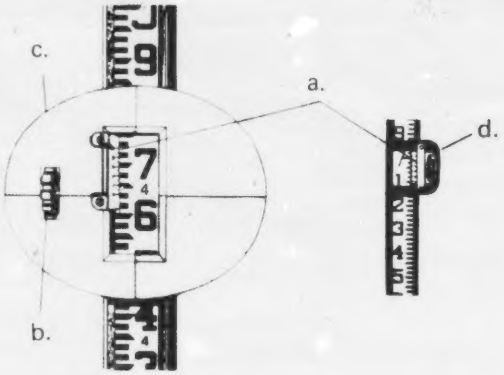
7. Read the following self-reading rods, placing the correct readings in the blanks provided.





a. ______________________   b. ______________________

8. Identify the parts of the rod.



a. ____________________ c. ____________________

b. ____________________ d. ____________________

9. Match the parts of the rod on the right to their uses on the left. Place the appropriate numbers in the blanks provided.

_____a. Holds the target in place

_____b. Holds the rod when extended

_____c. Red and white disc on rod used for certain types of readings

_____d. Found on targer face and rod clamp; enables reading to the nearest thousandths of a foot

1. Target face
2. Target clamp
3. Rod clamp
4. Vernier scale

10. Name the common errors in measurement.

a. ____

b. ____

c. ____

d. ____

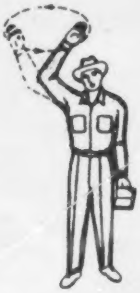
11. Name three rules for care of the farm level.

a. ____

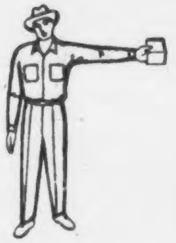
b. ____

c. ____

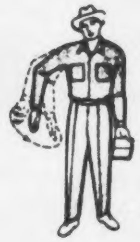
12. Identify the hand motions used by the instrument person to guide the target person.



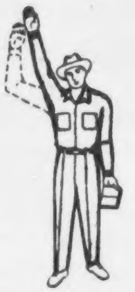
a. ______________________



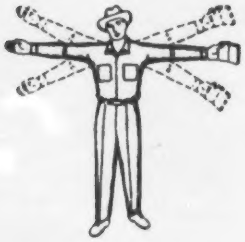
b. ______________________



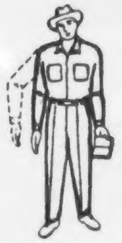
c. ______________________



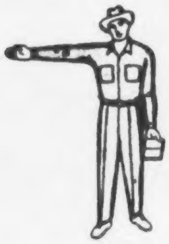
d. ______________________



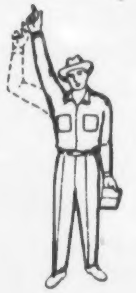
e. ______________________



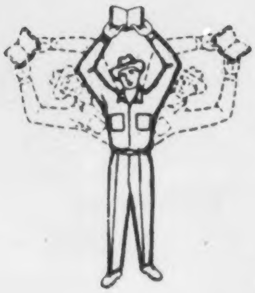
f. ______________________



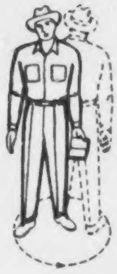
g. ______________________



h. ______________________



i. ____________________



j. ____________________

13. Select from the list below points to follow in keeping good field notes. Place an "X" in the appropriate blanks.

_____a. Reserve last five pages for index

_____b. Number pages in upper left-hand corner

_____c. Write descriptive title at top of first page for each job

_____d. Record name of survey party at top of left-hand side

_____e. Use 3H or 4H hard-lead pencil

_____f. Record numbers and letters in the best form possible

_____g. Do not erase

14. Calculate problems and record the results in the field notebook.

15. Demonstrate the ability to:

a. Set up and adjust the farm level.

b. Complete a differential leveling problem.

c. Complete a profile leveling problem.

(NOTE: If activities 14 and 15 have not been accomplished prior to the test, ask the instructor when they should be completed.)

USING THE FARM LEVEL
UNIT I

ANSWERS TO TEST

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

4 a. Elevation of the level line of sight or of the cross hairs in the telescope with respect to the bench mark

7 b. Level line through the instrument, as viewed by the eye; place where vertical hair crosses the horizontal hair

9 c. Method of determining the difference in elevation between two points

1 d. Permanent point of known or assumed elevation from which leveling surveys are started

6 e. Book used to keep surveying information

3 f. Rod reading taken on a point of known elevation

12 g. Rod used in leveling, normally graduated in tenths and hundredths of a foot

5 h. Solid location, usually a temporary stake, on which a foresight is taken, the instrument moved, and then a backsight taken to determine a new HI

11 i. Process by which the elevation of spaced grid points in a field are determined

10 j. Method of determining the elevation of a series of points at measured intervals along a line

2 k. Rod reading taken on a point of unknown elevation

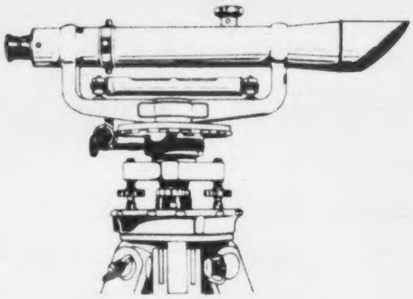
8 l. Rod that is read through the instrument by the instrument person

1. Bench mark (BM)
2. Foresight (FS)
3. Backsight (BS)
4. Height of instrument (HI)
5. Turning point (TP)
6. Field notebook
7. Line of sight
8. Self-reading rod
9. Differential leveling
10. Profile leveling
11. Topographic leveling
12. Level rod
13. Contour line
14. Error of closure

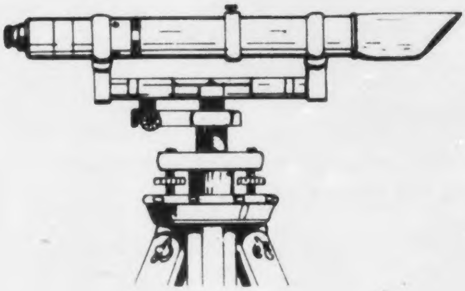
_13__ m. Line connecting points on the land surface which have the same elevation

_14__ n. Difference between the original BM1 elevation and the calculated BM1 elevation after a return check, if they fail to agree

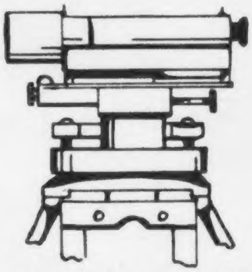
2. Identify the following types of levels.



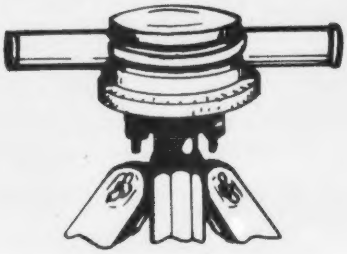
a. Builder's



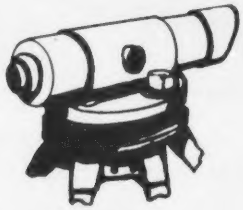
b. Engineer's dumpy



c. Engineer's wild tilting

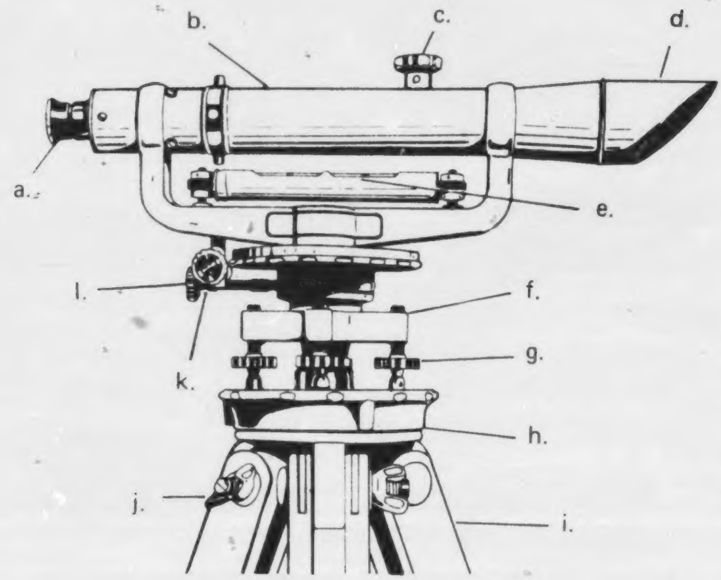


d. Turret



e. Engineer's Zeiss

3. Identify the parts of the farm level.


b.
c.
d.
a.
e.
l.
f.
g.
k.
h.
j.
i.

a. Eye piece

b. Telescope barrel

c. Focusing screw

d. Sun shade

e. Bubble tube

f. Leveling head

g. Leveling screw

h. Head plate

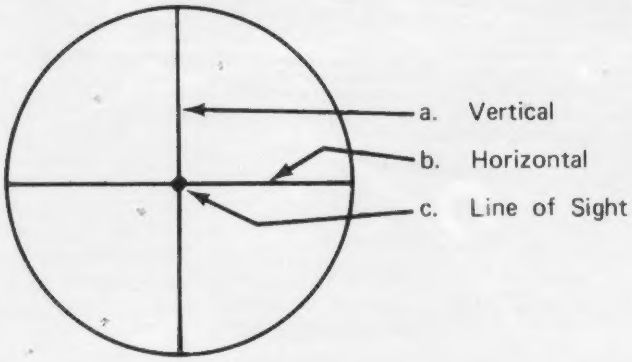
i. Tripod

j. Leg thumb nuts

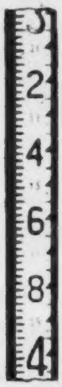
k. Slow motion screw

l. Clamp

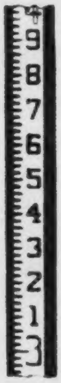
4. Identify the cross hairs in the telescope.


a. Vertical
b. Horizontal
c. Line of Sight

5. Identify the following types of self-reading rods.



a. Direct reading



b. Positive reading

6. Match the markings on the farm level on the right to the correct graduations on the left. Place the appropriate numbers in the blanks provided.

__1__ a. Designate feet

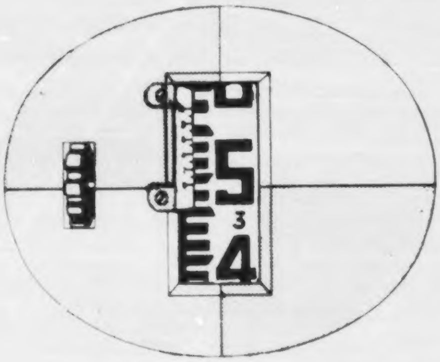
__4__ b. Reads thousandths of feet

__2__ c. Indicate tenths of feet

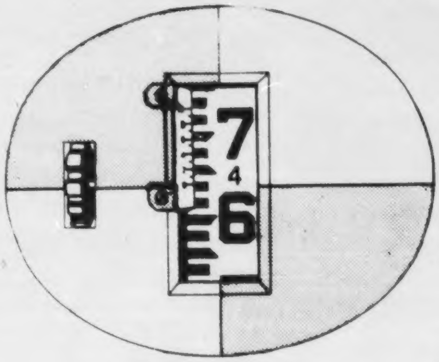
__3__ d. Show hundredths of feet

1. Red numbers
2. Black numbers
3. Black and white marks
4. Vernier scale

7. Read the following self-reading rods, placing the correct readings in the blanks provided.

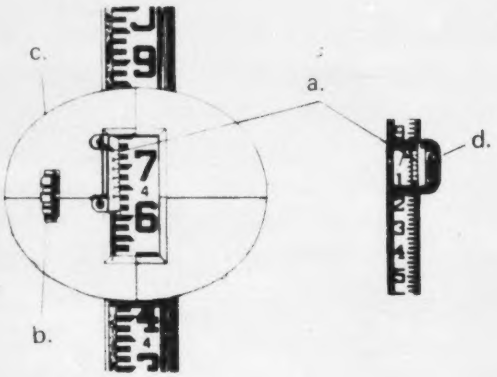


a. 3.49



b. 4.64

8. Identify the parts of the rod.



a. Vernier scale

b. Target clamp

c. Target face

d. Rod clamp

9. Match the parts of the rod on the right to their uses on the left. Place the appropriate numbers in the blanks provided.

__2__ a. Holds the target in place

__3__ b. Holds the rod when extended

__1__ c. Red and white disc on rod used for certain types of readings

__4__ d. Found on target face and rod clamp; enables reading to the nearest thousandths of a foot

1. Target face
2. Target clamp
3. Rod clamp
4. Vernier scale

10. Name the common errors in measurement.

a. Tape not pulled tight enough

b. Tape not in proper alignment

c. Plumb bob not used when measuring on slope

d. Reading or recording the wrong numbers

11. Name three rules for care of the farm level.

(NOTE: Any three of the following are acceptable.)

a. Protect against shock and vibration during transport

b. Keep in box except when in use

c. Place lens and tripod cap in box after removing from instrument

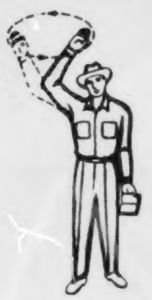
d. Attach instrument onto tripod carefully and firmly before moving tripod

e. Always use sun shade regardless of the weather

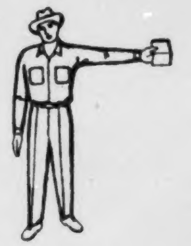
f. Clean lenses with soft tissue

g. Do not set up instrument in the shade and move to sun without releasing adjusting screws

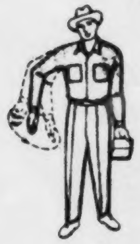
12. Identify the hand motions used by the instrument person to guide the target person.



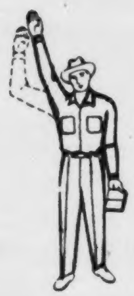
a. Turning point



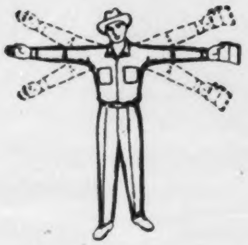
b. Move rod to the left



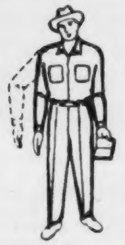
c. Come in



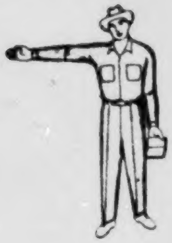
d. Use long rod



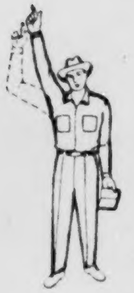
e. Observation completed; move on; understood



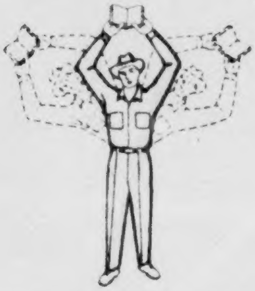
f. Move down



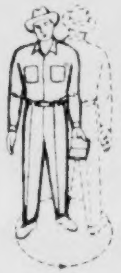
g. Move rod to the right



h. Move up



i. Wave rod from side to side



j. Wrong face; check clamp; rod upside down

13. Select from the list below points to follow in keeping good field notes. Place an "X" in the appropriate blanks.

______ a. Reserve last five pages for index

______ b. Number pages in upper left-hand corner

__X__ c. Write descriptive title at top of first page for each job

______ d. Record name of survey party at top of left-hand side

__X__ e. Use 3H or 4H hard-lead pencils

__X__ f. Record numbers and letters in the best form possible

__X__ g. Do not erase

14. Calculate problems and record the results in the field notebook.

15. Demonstrate the ability to:

a. Set up and adjust the farm level.

b. Complete a differential leveling problem.

c. Complete a profile leveling problem.

(NOTE: Activities 14 and 15 should be evaluated to the satisfaction of the instructor.)

LEGAL LAND DESCRIPTION
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to interpret a legal land description and identify within the state of Oklahoma any given piece of rural property. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with legal land description to the correct definitions.
2. Match the system of surveying to the states or areas in which they apply.
3. Label the principal meridians and base lines when drawn on a map of Oklahoma.
4. Identify the proper section number within the township.
5. Interpret a legal land description by determining the number of acres involved.
6. Identify the exact location of a given piece of rural property using legal description.

LEGAL LAND DESCRIPTION
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Make transparencies.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Provide a soil survey report for student reference.

   G. Give test.

II. Unit references:

   A. OSU Extension Facts. *Legal Land Descriptions in Oklahoma.* Stillwater, Oklahoma: Extension Service, Oklahoma State University.

   B. Cooperative Extension Service. *Soil: Extension Bulletin #9.* Fargo: North Dakota State University.

   C. United States Department of Agriculture, Soil Conservation Service. *Soil Survey: Ottawa County, Oklahoma.* Washington, D. C.: U. S. Government Printing Office.

LEGAL LAND DESCRIPTION
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Legal land description--Exact location of a property

B. Base line--Line running both east and west that extends across lands to be surveyed

C. Standard parallel lines--Lines running east and west every twenty-four miles parallel to the base line

(NOTE: These lines are numbered consecutively north or south from the base line.)

D. Principal meridians (PM)--Lines running both north and south from the initial point and extending across the area to be surveyed

(NOTE: There are twenty-seven principal meridians in U.S., two of which are used for Oklahoma surveys.)

E. Guide meridian lines--Lines running north and south every twenty-four miles almost parallel to the principal meridian and numbered consecutively east or west from the principal meridian

(NOTE: Convergence because of the earth's shape prevents them from being truly parallel and accounts for the correction made on some north and south public roads.)

F. Township (T)--Division of territory six miles long on its south, east, and west boundaries and slightly less than six miles on the north, which accounts for the correction lines located every six miles on the base line and on the standard parallel

G. Range (R)--Row or line of north-south townships six miles apart and numbered consecutively east or west from the principal meridian

H. Section (SEC.)--Composed of approximately 640 acres and measuring one mile square

(NOTE: North and west tier of sections within a township may be more or less than one square mile, usually less.)

I. Quarter-section (1/4)--Consists of 160 acres

(NOTE: Quarter-section is identified by direction with respect to section as northeast [NE], southeast [SE], northwest [NW], or southwest [SW]. Quarter-sections bordering the west and north sides of a township do not always contain 160 acres.)

INFORMATION SHEET

J. Correction lot-Fractional 40 acre tracts found on the west and north border of a township (Transparency 1)

K. River lot-Fractional 40 acre tracts found along rivers that have a mean high water mark of 132 feet or more (Transparency 1)

(NOTE: The area between the high water mark belongs to the state, thus reducing the size to less than a forty acre tract.)

II. Surveying systems used in U.S.

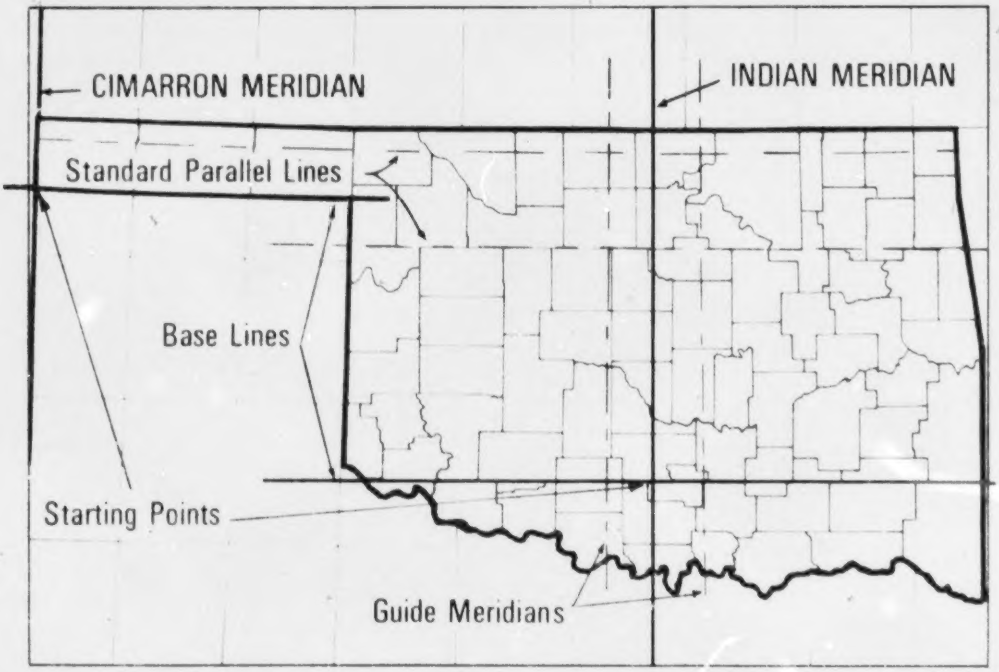
A. Metes-and-bounds--Used by the thirteen original colonies

B. Vara--Used by the state of Texas

C. Rectangular system (U.S. Land Survey System)--Applies primarily to all states except Texas and original thirteen colonies

III. Principal meridians and base lines (Transparency 2)

(NOTE: All legal land descriptions in Oklahoma include Indian or Cimarron Meridians.)


CIMARRON MERIDIAN
INDIAN MERIDIAN
Standard Parallel Lines
Base Lines
Starting Points
Guide Meridians

INFORMATION SHEET

IV. Procedure for numbering sections within township--Number always with 1 in the upper right hand corner and proceed in a "snake-like" or **S** fashion to the bottom right-hand corner of the township, ending with number 36 (Transparency 3, Assignment Sheet #1)

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

V. Determining number of acres included in legal land description (Transparency 4, Assignment Sheet #2)

A. Section--Indicates 640 acres

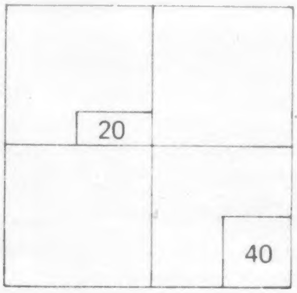
B. Two letters appearing together (SW, NE, NW, or SE) indicate 1/4 of whatever follows

C. One letter (N, S, E, or W) may or may not be followed by 1/2 or ^{2}, but always means 1/2 of whatever follows

D. Word *and* means the description of another tract is beginning

(NOTE: Acreage can quickly be determined by reading the description backward.)

Example: S 1/2 SE 1/4 NW 1/4 SEC. 7 and SE 1/4 SE 1/4 SEC. 7



INFORMATION SHEET

1. 20 acres referred to in first legal description S 1/2 SE 1/4 NW 1/4 SEC. 7
2. 40 acres referred to in last legal description SE 1/4 SE 1/4 SEC. 7

VI. Locating rural property within Oklahoma (Assignment Sheet #3)

A. Locate initial or starting point (Transparency 2)

1. Point where Cimarron Meridian (CM) intersects with base line is initial point for panhandle counties
2. Point where Indian Meridian (IM) intersects base line is initial point for main body of Oklahoma

B. Locate township--Every township is described with reference to the intersection of the principal meridian and the base line (Transparency 5)

1. Each east-west tier of townships is numbered consecutively north or south from the base line

   Example: Township 2 north (T2N) or township 4 south (T4S)

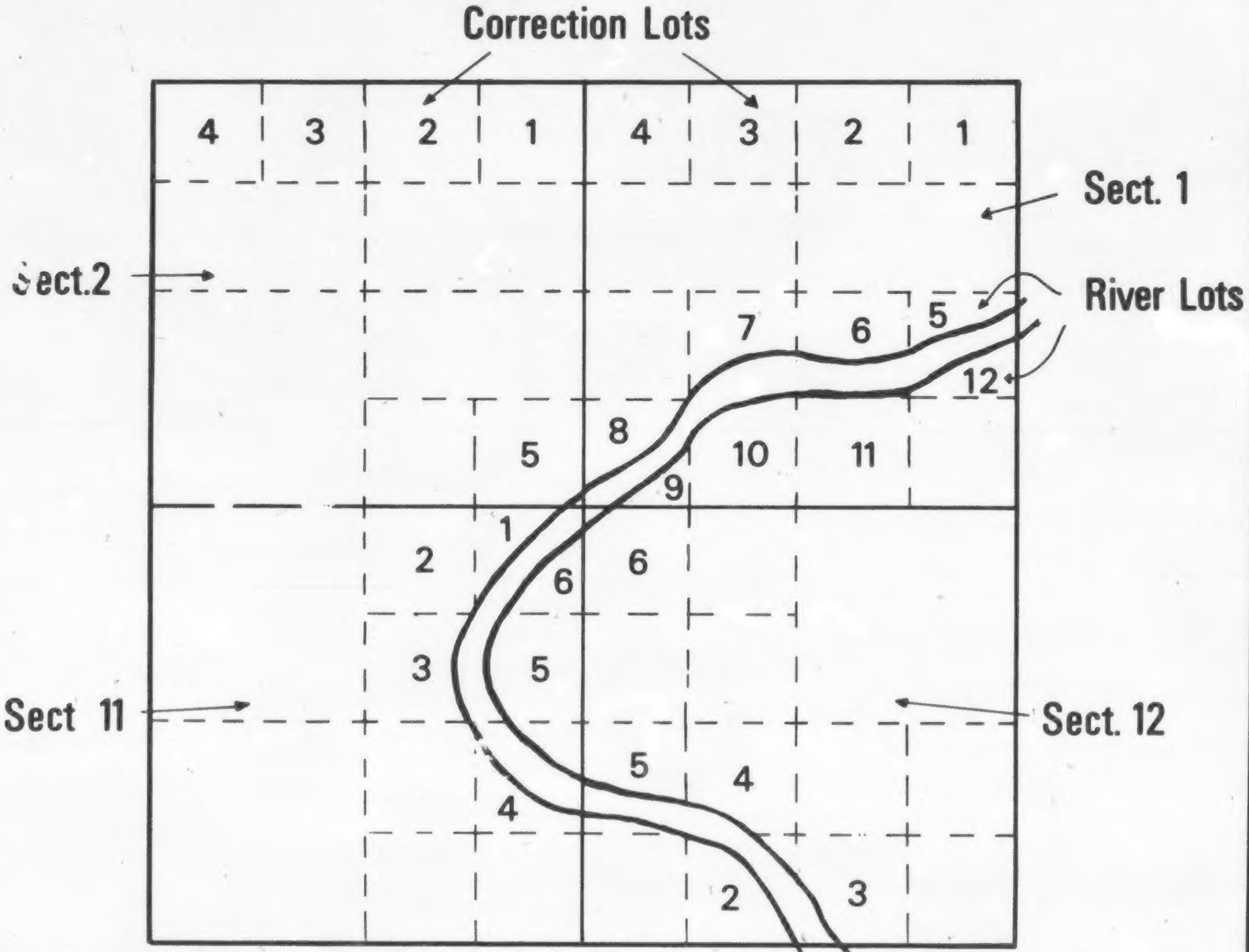
2. Each range is numbered consecutively east or west from the principal meridian

   Example: Range 2 east (R2E) or range 5 west (R5W)

C. Locate section within township--Numbering begins with 1 in upper right hand corner and proceeds in a "snake-like" or **S** fashion to the bottom right hand corner of the township, ending with number 36

(NOTE: Sections are divided into half sections, quarters, or smaller tracts.)

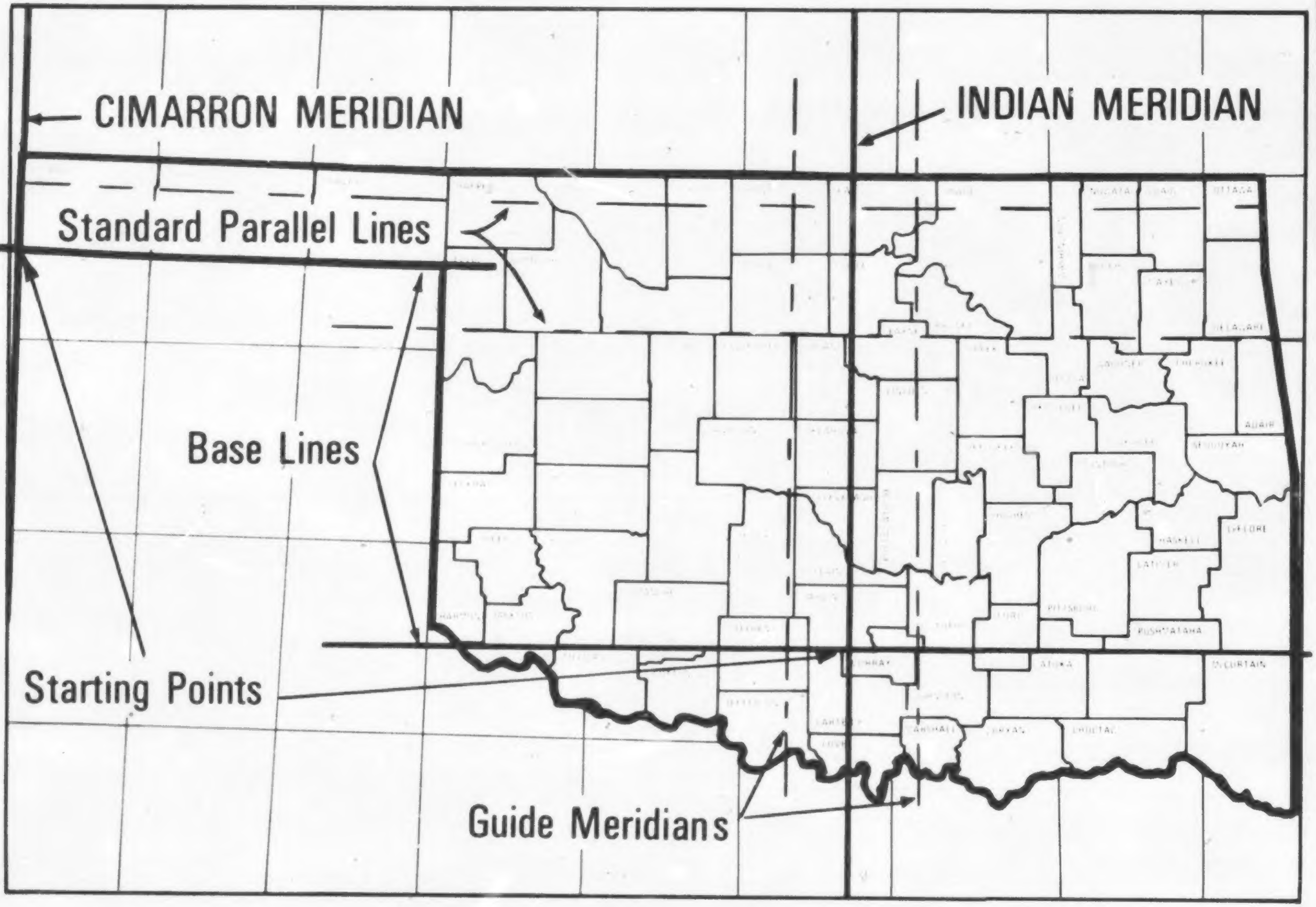
Numbering River Lots and Correction Lots


Correction Lots
4
3
2
1
4
3
2
1
Sect. 1
Sect.2
River Lots
5
7
6
12
8
5
10
11
9
1
2
6
6
3
5
Sect 11
Sect. 12
5
4
4
2
3

Lot numbers usually run downstream to section Line then back upstream to line.

905

Locating Principal Meridians and Base Lines in Oklahoma


CIMARRON MERIDIAN
INDIAN MERIDIAN
Standard Parallel Lines
Base Lines
Starting Points
Guide Meridians

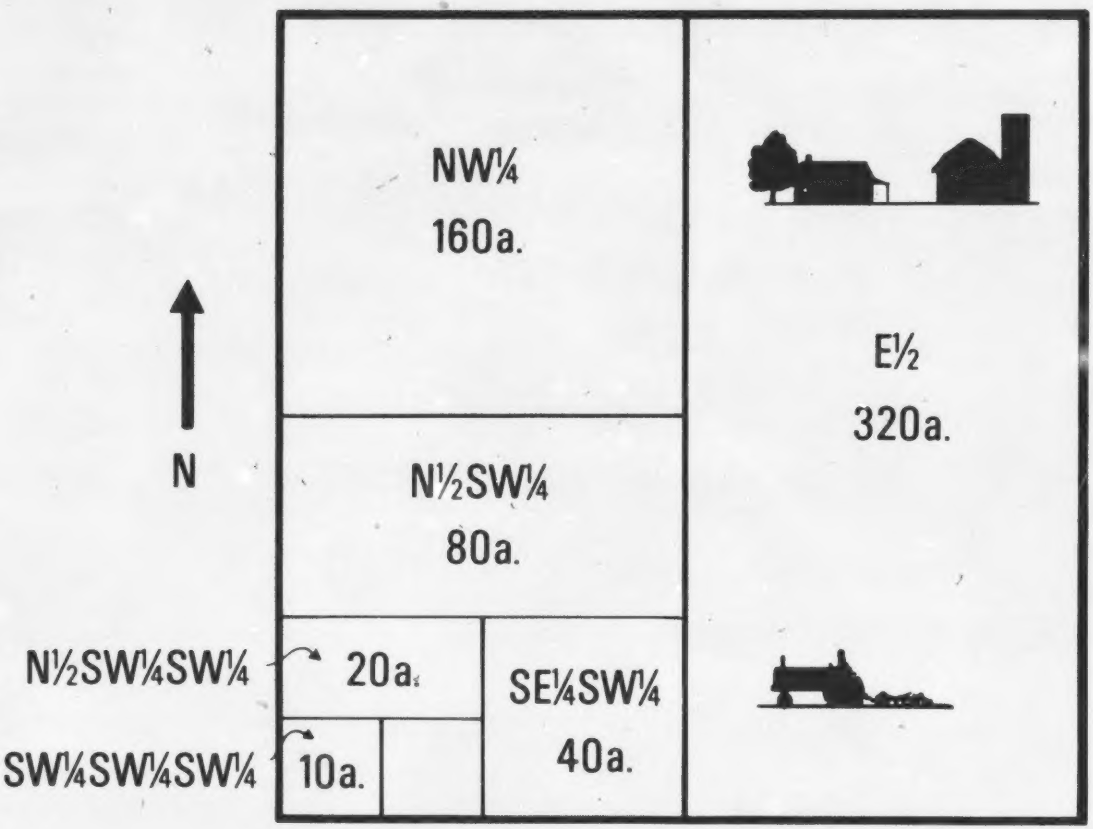
Numbering Sections Within Township

↑
N

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

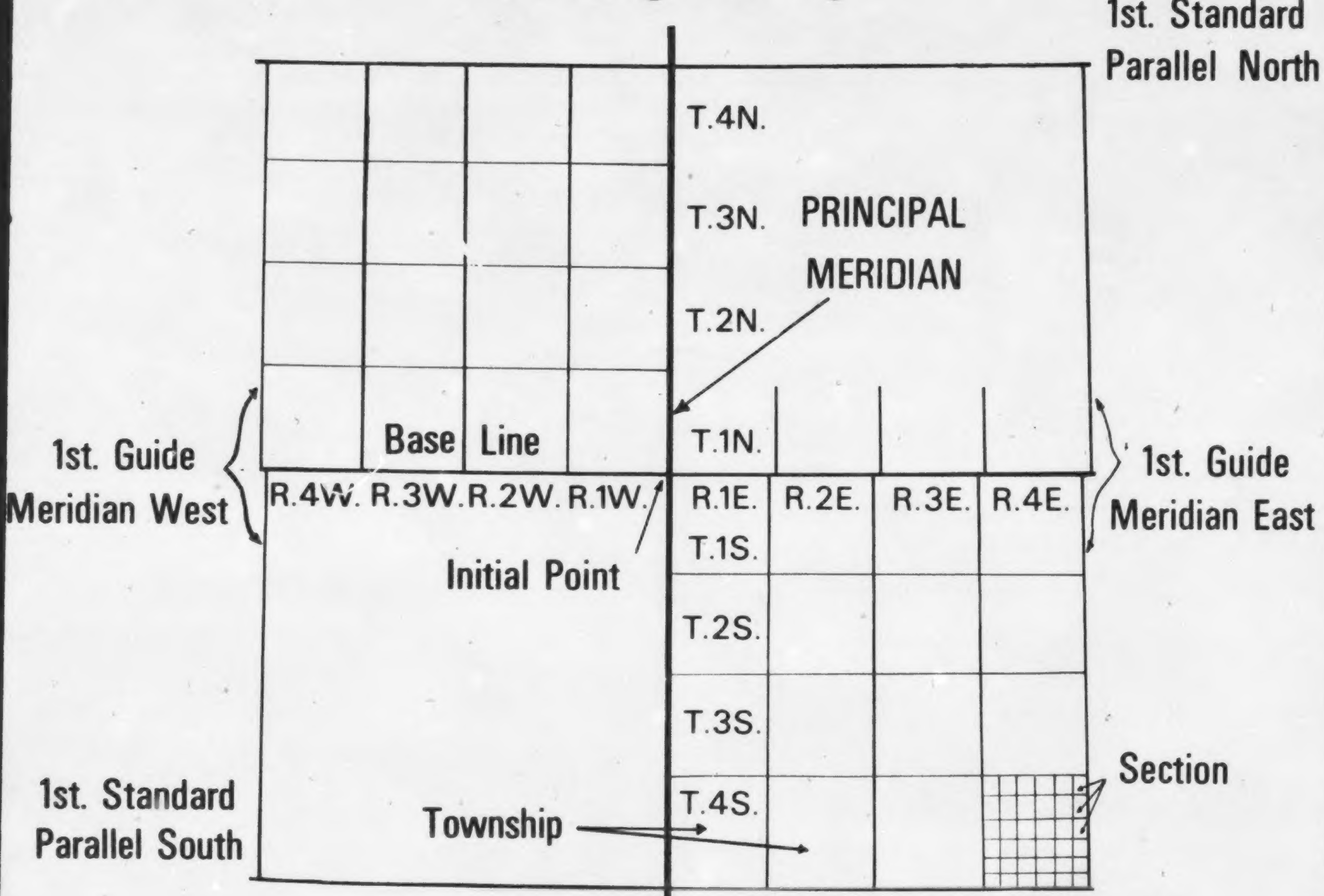
Townships are divided into 36 one-mile-square sections.

Dividing Sections into Smaller Tracts


NW¼
160a.
E½
320a.
N
N½SW¼
80a.
N½SW¼SW¼
20a.
SE¼SW¼
40a.
SW¼SW¼SW¼
10a.

Sections of land are divided into quarters or smaller tracts.

Reading a Map

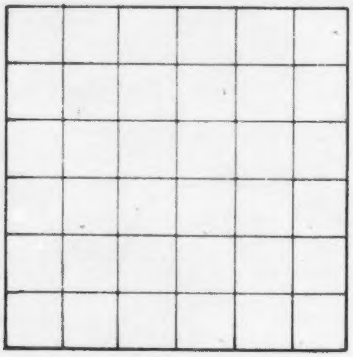

1st. Standard
Parallel North
T.4N.
T.3N.
PRINCIPAL
MERIDIAN
T.2N.
T.1N.
Base Line
1st. Guide
Meridian West
1st. Guide
Meridian East
R.4W.
R.3W.
R.2W.
R.1W.
R.1E.
R.2E.
R.3E.
R.4E.
T.1S.
Initial Point
T.2S.
T.3S.
T.4S.
Section
1st. Standard
Parallel South
Township

LEGAL LAND DESCRIPTION
UNIT II

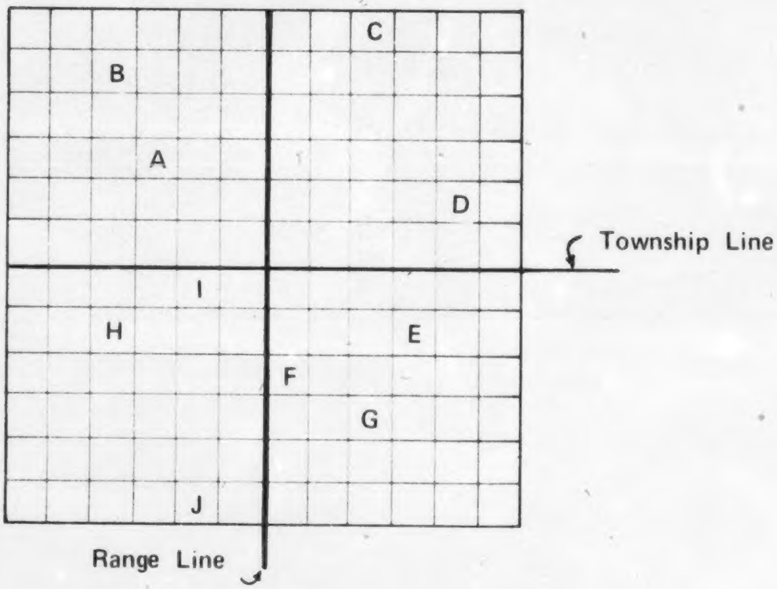
ASSIGNMENT SHEET #1--IDENTIFY SECTION NUMBERS WITHIN A TOWNSHIP

Answer the following problems relating to the numbering of sections.

1. Number the sections within the township drawn below.



2. Using the illustration below, list the section number of
A_____, B_____, C_____, D_____, E_____, F_____, G_____,
H_____, I_____, J_____.


C
B
A
D
Township Line
I
H
E
F
G
J
Range Line

LEGAL LAND DESCRIPTION
UNIT II

ASSIGNMENT SHEET #2--INTERPRET NUMBER OF ACRES INVOLVED IN LEGAL LAND DESCRIPTIONS

Solve the following problems.

1. How many acres are in the tracts described below?

   a. NW 1/4 and S 1/2 SEC. 11 ____________________

   b. N 1/2 N 1/2 SW 1/4 and S 1/2 NE 1/4 of SEC. 10 ____________________

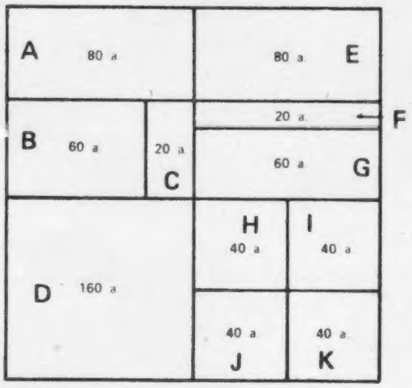
   c. SE 1/4 and SE 1/4 SW 1/4 SEC. 12 and N 1/2 N 1/2 S 1/2 SEC. 13 ____________________

   d. S 15 acres of N 2 NW 1/4 NW 1/4 and S 1/2 NW 1/4 NW 1/4 SEC. 8 ____________________

   e. N 1/2 SW 1/4 NW 1/4 SEC. 8 ____________________

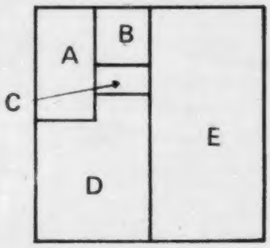
2. Describe in legal terms the fractional parts of the following drawing.

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________
   f. ____________________
   g. ____________________
   h. ____________________
   i. ____________________
   j. ____________________
   k. ____________________


A
80 a
80 a
E
20 a
F
B
60 a
20 a
C
60 a
G
H
40 a
I
40 a
D
160 a
40 a
J
40 a
K

ASSIGNMENT SHEET #2

3. Give the legal description and acreage in the following tracts in SEC. 21 T16N R14W IM.



a. Description ____________________

Acres ____________________

b. Description ____________________

Acres ____________________

c. Description ____________________

Acres ____________________

d. Description ____________________

Acres ____________________

e. Description ____________________

Acres ____________________

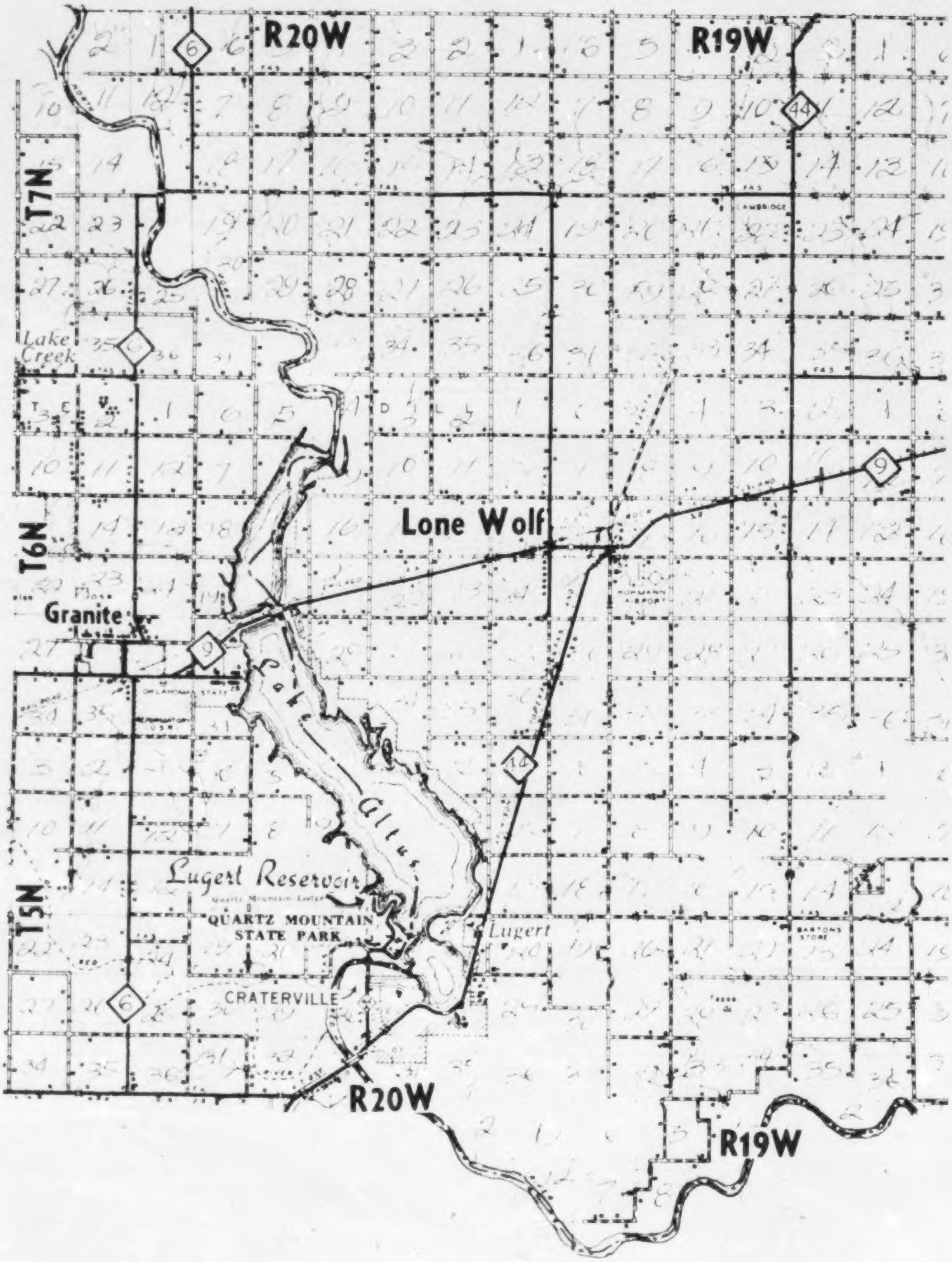
LEGAL LAND DESCRIPTION
UNIT II

ASSIGNMENT SHEET #3--IDENTIFY RURAL PROPERTY IN OKLAHOMA

Using the map on the next page, answer the following questions.

1. According to the map, what is located on the following property?
   a. SEC. 20 T6N R19W IM ______________________
   b. SEC. 36 T6N R21W IM ______________________
   c. SEC. 18 T6N R19W IM ______________________
2. Using the map, what is the legal description for the following listed names?
   a. Cambridge ______________________
   b. Barton's Store ______________________
   c. Granite ______________________
3. Approximately how many miles west of the Indian Meridian is the town of Lone Wolf?
4. Approximately how far north from the base line is the town of Granite?

ASSIGNMENT SHEET #3


R20W
R19W
T7N
T6N
T5N
6
44
9
Lake Creek
Lone Wolf
Granite
Lake Altus
Lugert Reservoir
Quartz Mountain Lodge
QUARTZ MOUNTAIN STATE PARK
Lugert
CRATERVILLE
R20W
R19W

LEGAL LAND DESCRIPTION
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1.

↑ N

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

2.
   - a. 22
   - b. 9
   - c. 4
   - d. 26
   - e. 10
   - f. 18
   - g. 21
   - h. 9
   - i. 2
   - j. 35

Assignment Sheet #2

1.
   - a. 480
   - b. 120
   - c. 280
   - d. 35
   - e. 20

2. a. N 1/2 NW 1/4
   b. SW 1/4 NW 1/4 and W 1/2 SE 1/4 NW 1/4
   c. E 1/2 SE 1/4 NW 1/4
   d. SW 1/4
   e. N 1/2 NE 1/4
   f. N 1/2 N 1/2 S 1/2 NE 1/4
   g. S 1/2 S 1/2 NE 1/4 and S 1/2 N 1/2 S 1/2 NE 1/4
   h. NW 1/4 SE 1/4
   i. NE 1/4 SE 1/4
   j. SW 1/4 SE 1/4
   k. SE 1/4 SE 1/4
3. a. W 1/2 NW 1/4 SEC. 21 T16N R14W IM--80 acres
   b. NE 1/4 NW 1/4 SEC. 21 T16N R14W IM--40 acres
   c. N 1/2 SE 1/4 NW 1/4 SEC. 21 T16N R14W IM--20 acres
   d. SW 1/4 and S 1/2 SE 1/4 NW 1/4 SEC. 21 T16N R14W IM--180 acres
   e. E 1/2 SEC. 21 T16N R14W IM--320 acres

Assignment Sheet #3

1. a. Hohmann Airport
   b. Oklahoma Reformatory
   c. Lone Wolf
2. a. SEC. 22 T7N R19W IM
   b. SEC. 23 T5N R19W IM
   c. SEC. 25 and SEC. 26 T6N R21W IM
3. 6 miles per range x R19W = 114 miles
4. 6 miles per township x T5N plus 1 mile into T6N = 31 miles

LEGAL LAND DESCRIPTION
UNIT II

TEST

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

______a. Lines running both north and south from the initial point and extending across area to be surveyed

______b. Division of territory six miles long on its south, east, and west boundaries and slightly less than six miles on the north, which accounts for the correction lines located every six miles on the base line and on the standard parallel

______c. Lines running north and south every twenty-four miles almost parallel to the principal meridian and numbered consecutively east or west from the principal meridian

______d. Exact location of a property

______e. Line running both east and west that extends across lands to be surveyed

______f. Lines running east and west every twenty-four miles parallel to the base line

______g. Row or line of north-south townships six miles apart and numbered consecutively east or west from the principal meridian

______h. Consists of 160 acres

______i. Composed of approximately 640 acres and measuring one mile square

______j. Fractional 40 acre tracts found on the west and north border of a township

______k. Fractional 40 acre tracts found along rivers that have a mean high water mark of 132 feet or more

1. Base line
2. Township (T)
3. Range (R)
4. Legal land description
5. Principal meridians (PM)
6. Correction lot
7. Section (SEC.)
8. Standard parallel lines
9. Guide meridian lines
10. Quarter section (1/4)
11. River lot

2. Match the system of surveying on the right to the states or areas in which they apply.

_____a. Applies primarily to all states except Texas and the original thirteen colonies

_____b. Used by the state of Texas

_____c. Used by the thirteen original colonies

1. Vara

2. Metes-and-bounds

3. Rectangular system (U.S. Land Survey System)

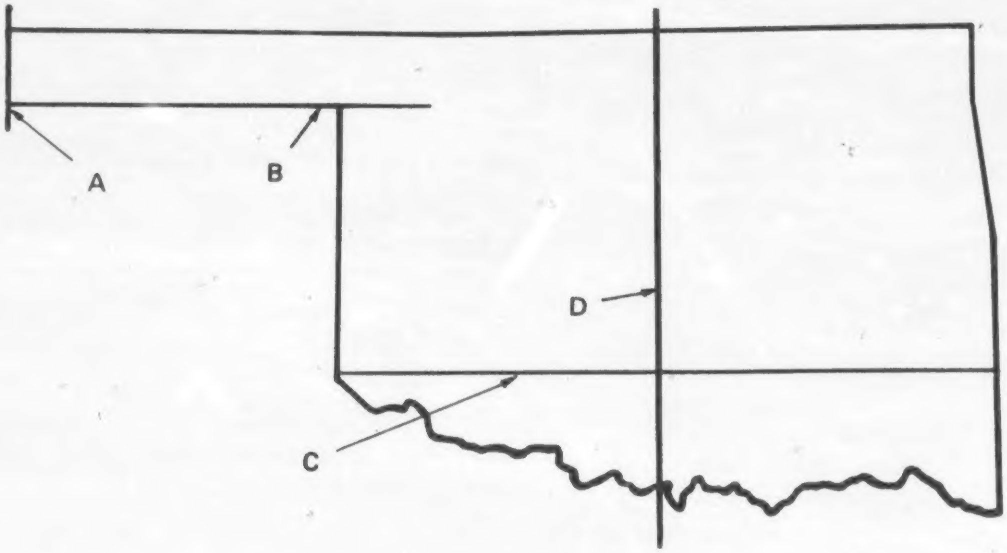
3. Label the principal meridians and base lines on the map below.

a. ____________________

b. ____________________

c. ____________________

d. ____________________



4. Identify the proper section number within the township illustrated below.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

			A		
B					
			C		
					D

5. Interpret the following legal land description by determining the number of acres involved.

N 1/2 SE 1/4 NE 1/4 SEC. 7 and SE 1/4 SEC. 7

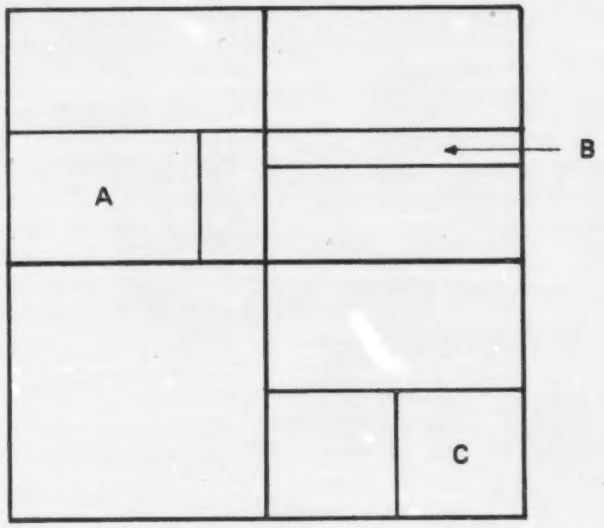
Total Acres: ____________________

6. Identify the exact location of the property listed in the section below. Use legal descriptive terms.

a. ______________________________

b. ______________________________

c. ______________________________



LEGAL LAND DESCRIPTION
UNIT II

ANSWERS TO TEST

1. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

__5__ a. Lines running both north and south from the initial point and extending across area to be surveyed

__2__ b. Division of territory six miles long on its south, east, and west boundaries and slightly less than six miles on the north, which accounts for the correction lines located every six miles on the base line and on the standard parallel

__9__ c. Lines running north and south every twenty-four miles almost parallel to the principal meridian and numbered consecutively east or west from the principal meridian

__4__ d. Exact location of a property

__1__ e. Line running both east and west that extends across lands to be surveyed

__8__ f. Lines running east and west every twenty-four miles parallel to the base line

__3__ g. Row or line of north-south townships six miles apart and numbered consecutively east or west from the principal meridian

__10__ h. Consists of 160 acres

__7__ i. Composed of approximately 640 acres and measuring one mile square

__6__ j. Fractional 40 acre tracts found on the west and north border of a township

__11__ k. Fractional 40 acre tracts found along rivers that have a mean high water mark of 132 feet or more

1. Base line
2. Township (T)
3. Range (R)
4. Legal land description
5. Principal meridians (PM)
6. Correction lot
7. Section (SEC.)
8. Standard parallel lines
9. Guide meridian lines
10. Quarter section (1/4)
11. River lot

2. Match the system of surveying on the right to the states or areas in which they apply.

3 a. Applies primarily to all states except Texas and the original thirteen colonies

1 b. Used by the state of Texas

2 c. Used by the thirteen original colonies

1. Vara
2. Metes-and-bounds
3. Rectangular system (U.S. Land Survey System)

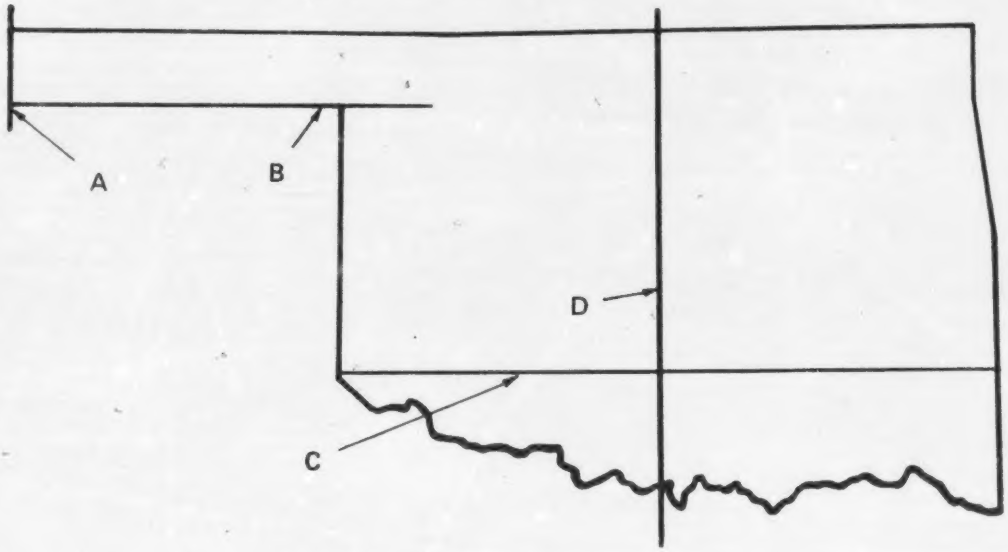
3. Label the principal meridians and base lines on the map below.

a. Cimmaron Meridian (PM)

b. Base line (for Panhandle counties)

c. Base line (for main body of Oklahoma)

d. Indian Meridian (PM)



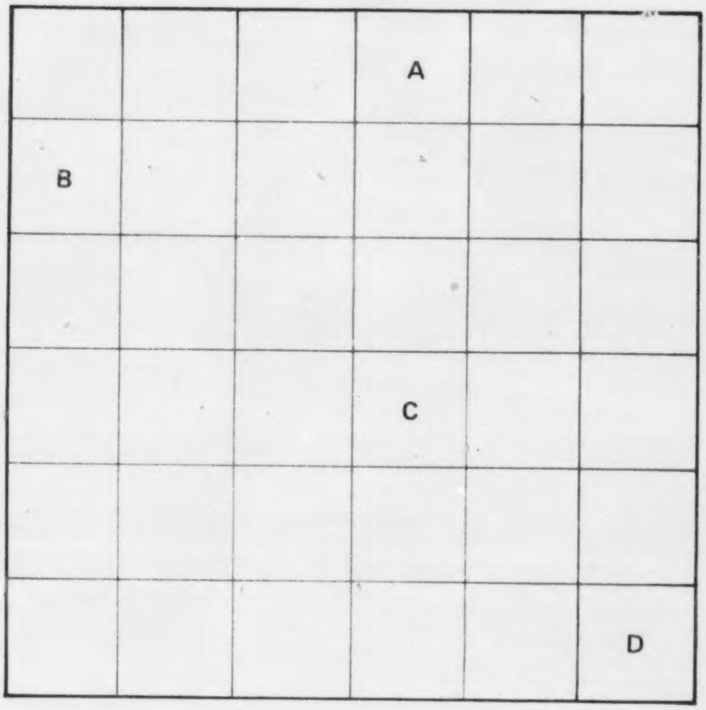
4. Identify the proper section number within the township illustrated below.

   a. 3

   b. 7

   c. 22

   d. 36



5. Interpret the following legal land description by determining the number of acres involved.

   N 1/2 SE 1/4 NE 1/4 SEC. 7 and SE 1/4 SEC. 7

   Total Acres: 180

6. Identify the exact location of the property listed in the section below. Use legal descriptive terms.

   a. SW 1/4 NW 1/4 and W 1/2 SE 1/4 NW 1/4 of SEC. 7

   b. N 1/2 N 1/2 S 1/2 NE 1/4 of SEC. 7

   c. SE 1/4 SE 1/4 of SEC. 7